POWER

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Loyalty

IT HAS been suggested that I write a foreword on Loyalty. I doubt if I am a shining example of that quality, at least in the dictionary sense.

"Faithful to the law; upholding the lawful authority."

Well, faithfulness to the law is not a quality to inspire much of an encomium. One may be faithful to the law because of the penalty attached to its infraction, in which case the sentiment involved is the ignoble one of caution or fear.

He may be induced to obey the law even though he does not consider it a just one, by the conviction that the general well being will be favored by such obedience; in which case I should commend his humanitarianism, of which loyalty was only an incident.

Many people whom I respect highly are habitual breakers of certain laws. They play golf on Sunday, violate the traffic laws and other things. On the other hand, many people conduct themselves entirely within the law in such ways as to incite my resentment and contumely.

Is a man loyal who obeys the laws that he approves and infracts the others? If not, how many of us can qualify?

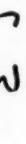
"Faithful to the prince or sovereign to whom one is subject."

I cannot seem to get up much enthusiasm about this either. I cannot admire that quality that makes men spring at each other's throats at the command of overlords in a quarrel of the merits of which they know nothing. I cannot share that obsequiousness with which men fashion their conduct to their rulers. I think I can appreciate commanding qualities and great achievement and vested authority, but I cannot say with Undermaster Titmarsh that "I like this feeling of decent fear and trembling with which a modest spirit salutes a great man."

Loyalty in this sense has too much of subserviency about it. It is always the loyal subject, the loyal wife; never the loyal husband.

But I can understand and esteem that devotion to a person or a cause through friendship, admiration or conviction of his or its worthiness that holds men steadfast against treachery whatever the promise of personal advantage or the provocation of unrecognized merit or unwarranted abuse.

And if that is loyalty, I am for it one hundred per cent.



Admitting Air to Turbine Runners Improves Efficiency

By S. LOGAN KERR
Assistant Hydraulic Engineer, Wm. Cramp & Sons Ship & Engine Building Co.

METHODS of Admitting Air to Turbine Runners To Improve the Efficiency and How To Make Tests To Determine the Adjustment of the Air Valves To Obtain the Most Efficient Operating Performance.

IN LOW- or medium-head hydraulic plants some increase in efficiency at part load is usually obtainable by admitting small quantities of air to the runner of the turbine. The effect of this air admission is to break up the eddy losses in the runner and to prevent the so-called pumping action in the draft tube that occurs at part-load operation. By reducing these internal losses, the efficiency of the turbine is increased materially. The benefits that can be obtained from a

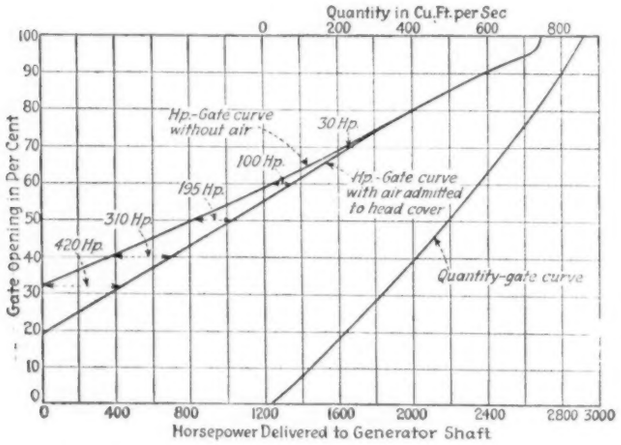


Fig. 1—Curves show power gain by admitting air to turbine runner

reduction in these losses will be found only in the range of output where the losses assume fairly large proportions.

As the load on the unit increases the eddy losses decrease, and it is only in the lower third, or at the most the lower half, of the range of output of the turbine that material benefits can be secured. In fact, the admission of air as full load is approached may reduce the efficiency rather than increase it, and hence the setting of the air admission valves on a turbine must be determined very carefully after installation, in order to secure the best results.

The actual admission of air may be accomplished by opening up holes in the head cover, which will allow air to pass through the cored passages of the runner hub into the draft tube. Another method is to insert a pipe in the wall of the draft tube and project it into the flow line a sufficient distance to reach the inner zone of flow. This inner zone at part load has a tendency to surge and is responsible for a portion of the losses in the lower range of the turbine output. With a high central cone in the draft tube the greater portion of this unsteady flow is avoided, but at extreme low gate openings the inner zone of flow occupies about 60 per cent of the cross-section of the draft tube. The air-control valve should be designed so that it can be operated by the turbine gates and its area varied as required with respect to the gate stroke. The valve should be adjustable and its correct setting should be determined in the field. The maximum opening will be required at rated speed and no load, and the area of the air inlet will be about one-half of one per cent of the gross area of the runner throat; that is, the area corresponding to

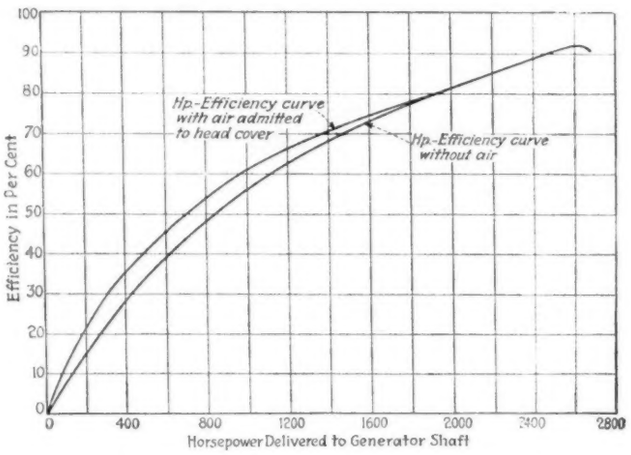


Fig. 2—Curves showing gain in efficiency by admitting air to the runner

the minimum diameter of the water passage through the turbine runner.

To secure the correct setting there are several means available, but the most convenient method is probably the power-gate opening test, which can be made without much trouble and without the necessity of measuring the flow through the turbine. The unit should be operated on hand control or on the governor load limit and the gates set at various points, preferably the even tenths of the gate stroke up to about 70 or 80 per cent of the full travel. Accurate readings of generator output should be taken at each of these gate settings and the headwater and tailwater elevations accurately measured. The net head on the unit should also be taken if there is any appreciable loss in the water conduit leading up to the turbine. In computing the test results,

the output should be referred to a constant net head in order to avoid the possibility of incorrect conclusions as to the amount of horsepower increase obtained. The unit should be operated as near to the correct speed as possible, as excessive variation from normal speed might change the conditions sufficiently to give incorrect results when comparisons are made with operation at the correct speed.

The first test should be made with all the air inlet valves closed and subsequent tests run with various openings of the air valve. In this manner a series of power-gate opening curves will be secured, and for a given gate opening the variation in power with respect to the area of the air inlet can be determined, and thus the correct setting of the air valve established for each particular gate opening. Great care must be taken in setting the turbine gates at the desired opening during the test so that all the readings will be made either with increasing or else with decreasing gate openings. This will eliminate any lost motion in the gate operation mechanism or deflection in the gate shaft due to the hydraulic forces.

Results Obtained from Tests

The curves, Fig. 1, show the results obtained from a test similar to that previously described. This unit had a rating of 2,500 hp., under a 30-ft. head and was of the vertical-shaft, single-runner, high-speed, propeller type. An accurate efficiency test had previously been made, and the curves of horsepower and discharge with respect to gate opening had been determined. The maximum increase in power for each particular gate opening was determined as previously described, during a supplementary test. These increases in output were then added to the power-gate opening curve, Fig. 1, and the efficiency computed, assuming that the discharge-gate opening curve would be the same in either case.

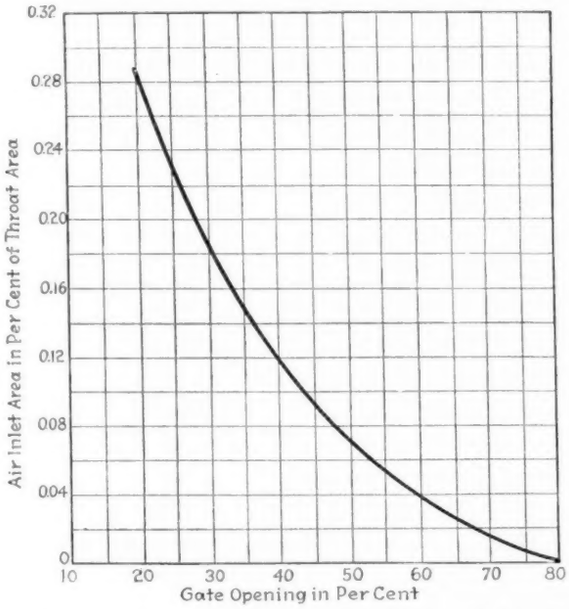


Fig. 3—Size of air-inlet openings for different gate positions

From these curves it will be seen that the greatest gain in power is, as previously mentioned, at part gate. At 32 per cent gate opening and without air admitted to the runner, the turbine delivers no power to the generator shaft. With air admitted to the runner and 32 per cent gate opening, the turbine delivers 420 hp. to the generator shaft, which is equivalent to about 17 per cent of the normal rating of the unit. This increase in power decreases as the load on the unit increases until at about 1,800-hp. load the gate opening is approximately the same with or without air admitted to the runner.

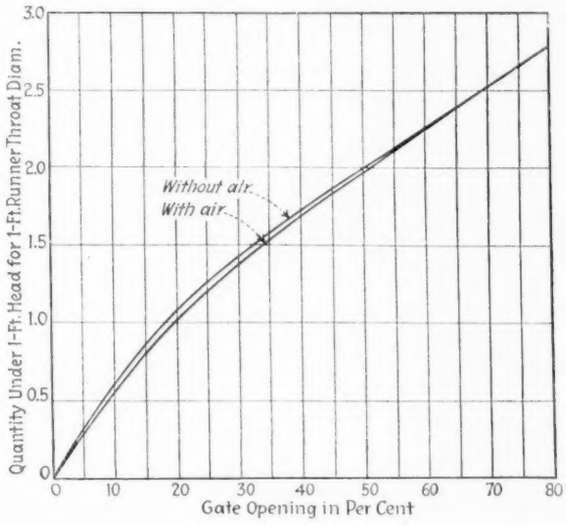


Fig. 4—Water quantities through model turbine with and without air admission

Fig. 2 shows a comparison of the efficiency curves with and without air admission on this particular unit. The maximum gain in efficiency is about 7 per cent, which occurs around 400-hp. load. Fig. 3 gives the variation of area of the air-inlet valve with respect to gate opening as determined from the tests. The area has been expressed in percentage of the gross area of the runner throat rather than square inches, in order to give a general idea of the requirements for air admission for other units.

Variation of Water Quantity

It was not possible at the time of the supplementary test to measure the variation of water quantity with respect to gate opening. A later test was made on a model turbine with a similar runner and draft tube, and the curve of discharge with respect to gate opening was established with the model turbine operating without air admission. This test was followed by a similar test under the same conditions, but with a small quantity of air admitted to the runner in about the same proportion as on the main unit. The two curves shown in Fig. 4 indicate that the quantity is actually reduced with air admission rather than increased. The greatest difference in efficiency in the range of normal operation, due to the decrease in quantity will be in the neighborhood of one-half of one per cent. For ordinary operating requirements it is sufficiently accurate to assume a discharge at a given gate opening to be the same with and without air admission, provided the area of the air-inlet valve is determined to give the best results.

Another method that might be employed to determine the correct gate opening of the air valve is to operate

the turbine at a given gate setting and then adjust the air valve until the maximum increase in output is secured. The turbine could then be operated at a different gate opening and the correct setting of the air valve determined at this point. By taking a sufficient number of points, the variation of area of the air inlet as illustrated in Fig. 3 can then be secured and the final adjustment made on the inlet-valve mechanism to give this setting in operation.

Care should be taken that the valve is tightly closed beyond the point at which the admission of air is no longer a benefit, as it has been found that the power will be decreased if the air inlet is opened beyond this point, and consequently the efficiency will also be reduced.

The admission of air for increasing the efficiency of part loads may also be applied to the Francis turbine, although the benefits secured may not be so great as in the case of the higher specific-speed propeller types of turbines.

The effect of air admission should reduce the tendency toward runner corrosion by eliminating the eddies and surging within the runner itself. In many cases the governing characteristic of the turbine at rated speed and no load may be improved through air admission.

The use of air admission should be made only after a complete study of each individual case, in order to secure the best conditions and because there may be certain cases where the admission of air is not practicable, owing to the turbine setting or other local conditions. In general, however, for units having medium or high specific speeds considerable benefit may be obtained by the use of air admission.

Chart Calculates Proper Boiler Blowdown

By C. K. Jackson

IN A great many boiler plants the number of times the boilers are blown down, as well as the quantity of blowdown, is largely a matter of guesswork. This is particularly true of plants that have no regular system of water treatment.

All solids and impurities enter the boiler by way of the feed water. The water is continuously carried away as steam, leaving these solids behind to accumulate and multiply, to the exasperation of the boiler boss, who tries to get rid of them the best way he can, either by blowdown or turbining the tubes.

The amount of water he should blow down to maintain a limited concentration can be calculated as illustrated by the following example from our own experience. We keep the concentration of boiler water below 500 grains per gallon of total solids. Our feed water averages 10 grains of total solids per gallon, and our 6,000-sq.ft. water-tube boilers produce, on a 24-hour average, 27,000 lb. of steam an hour. This amounts to 648,000 lb. a day or about 80,000 gallons.

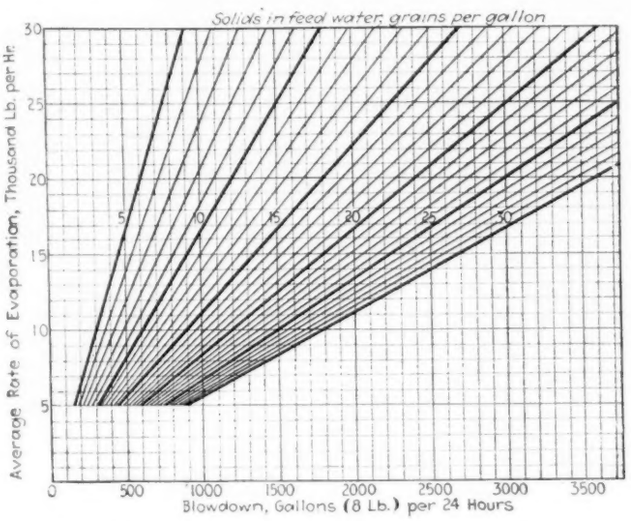
In other words, 80,000 gal. of feed water has to be supplied to the boiler each day to replace evaporation. With 10 grains per gallon, 800,000 grains of solids are added to the boiler water daily.

To maintain any existing concentration, all one has to do is to get rid of all the solids *added* to the boiler, keeping the original lot. In this case, therefore, we must blow down 800,000 grains of solids per day in any case. The *volume* of water blown will be less the greater the concentration to be maintained.

Since we are not to exceed a concentration of 500 grains per gallon in the boiler, the number of gallons of water at that concentration that will carry off the surplus solids will be 800,000 ÷ 500 = 1,600 gal. This is the number of gallons that must be blown down daily.

The measurement of blowdown in most boiler plants is the "gage," the distance between test cocks on the water column. On our boilers this distance is 4½ in., the calculated volume being about 435 gal. per gage. The number of gages to blow down would be 1,600 ÷ 435 = 3¾ approximately.

These calculations can be put in chart form for convenience in determining the blowdown under varying conditions of load and feed-water concentration. The



Blowdown required to maintain concentration of 500 grains of solids per gallon

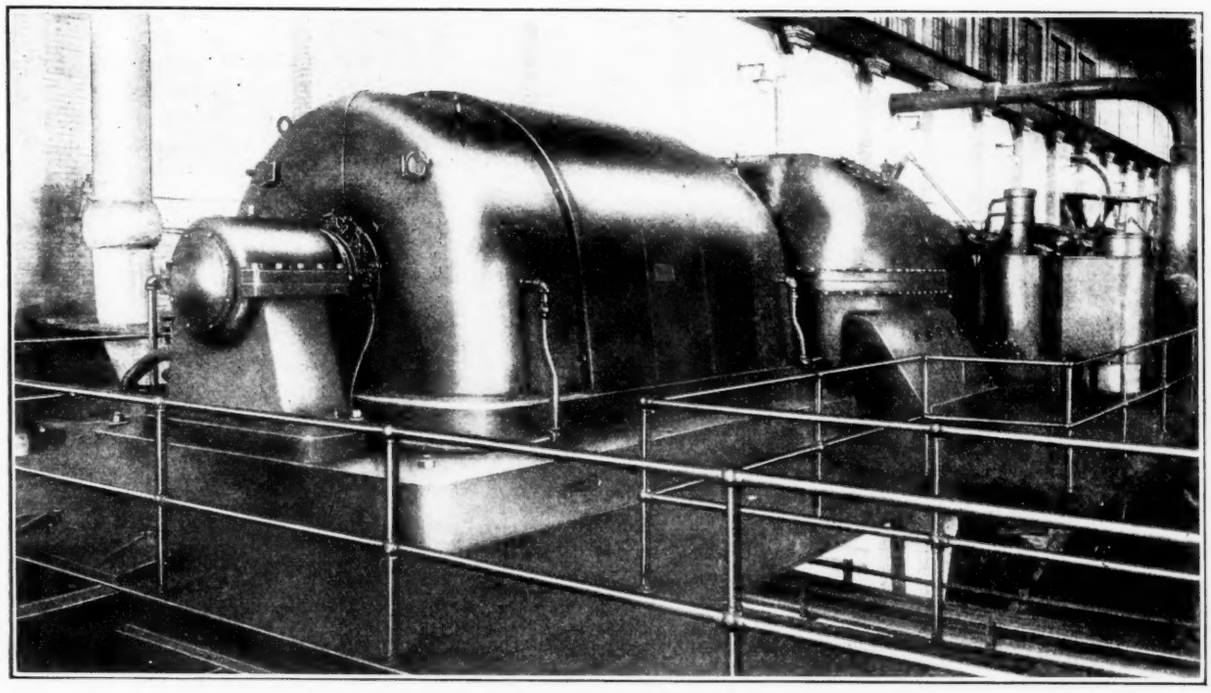
Move horizontally from rate of evaporation to grains per gallon in feed water and then drop down to the required blowdown.

accompanying chart gives the blowdown required to maintain a boiler-water concentration of 500 grains per gallon. For example, the chart indicates a blowdown of 900 gal. per day where a water with 10 grains total solids is evaporated at a rate of 15,000 lb. per hour.

This method should not be taken as perfect, as many factors enter into water calculations that cannot ordinarily be considered. Operating errors, such as measurement of amount of blowdown, averaging load, water level, etc., would offset attempts at great accuracy. A more important point is that of discharge of water with the steam. For boilers having very wet steam such water loss may be surprising. This entrained moisture, with its solids, is undesirable, causing clogging and erosion of superheater tubes, steam lines, turbine blading, valves, etc.

Boilers not equipped with special water-removing devices, may easily discharge one per cent of moisture or more from the boiler drums. The superheating of this steam later may evaporate the moisture, but obviously has no effect on the loss of solids from the drum.

In using the chart the "blowdown" obtained is the total volume of water to be disposed of in 24 hours. From this should be subtracted the gallons per 24 hours discharged as moisture in the steam. The remainder will be the actual blowdown required to maintain the given concentration.



Test of 15,000-Kw. Turbine

at the Cleveland Municipal Plant

By L. A. QUAYLE
Chief Mechanical Engineer, Cleveland Department of Public Utilities

WITH steam at moderate initial pressure and temperature, this turbine shows good results after six months of regular operation. Full load water rate 11.34 lb. per kw.-hr.

THE Municipal Power Plant at East Fifty-third Street in Cleveland, Ohio, contains at present three 5,000-, two 10,000- and one 15,000-kw. turbine generators. The turbines are of the straight reaction type, single flow, built for 225 lb. per sq.in. gage steam pressure and 125 deg. superheat. The first installation in this station consisted of three 5,000-kw. units with its complement of boiler equipment, and the last installation was the 15,000-kw. turbine generator.

The excitation current for all generators is supplied from separate exciter units. In this test the true output of the generator at the terminals includes the power supplied by the exciter, and in calculating the steam consumption of the unit the exciter input was deducted from the terminal output. The generators have a self-contained ventilating system, the fans being mounted directly on the rotor.

The 15,000-kw. turbine was officially tested for steam consumption on April 12 and 13, 1926. The tests were run at three loads corresponding to those at which guarantees of steam consumption were made by the manufacturer; namely, one-half, three-quarter and full.

The tests were performed with the unit in regular commercial service. The regulation and maintaining of a constant load was accomplished by operating this unit in parallel with other units in the station. Although the unit is normally operated with steam bled from two stages, the tests will run straight condensing since the guarantees were on that basis. The duration of each test was two hours, except when load conditions in the station would permit runs of longer duration, as at the fractional loads.

TABLE I—BRIEF SUMMARY, COMPARISON OF ACTUAL AND GUARANTEED STEAM RATES

Load, kw	7,572	11,301	14,744
Steam pressure:			
Throttle, lb. per sq.in. gage	221.6	220.2	218.6
Exhaust pressure, in. mercury abs.	1.00	1.01	1.02
Steam temperature:			
Throttle, deg. F.	574.9	556.8	539
Superheat, deg. F.	179.5	161.3	144.0
Net condensate by test, lb. per hr.	88,512	127,490	166,085
Net steam to turbine corrected to contract conditions, lb. per hr.	91,922	130,610	167,220
Steam rate by test, lb. per kw.-hr.	12.14	11.56	11.34
Guaranteed steam rate, lb. per kw.-hr.	12.35	11.76	11.46
Margin better than guarantee, per cent	1.70	1.70	1.05

The tests were conducted by the chief mechanical engineer's staff of testing engineers and witnessed by engineers of the manufacturer.

Observations were made by the city's observers, and duplicate hourly log sheets were kept. At the end of each hour a trial calculation was made, and these trial results for each load showed close agreement.

All the returned condensate, including the condensed steam from the steam-jet air pumps, was weighed on previously calibrated tank scales, tested by the city sealer. The steam used by the steam jets was determined by observing the temperature rise of the main condensate from the turbine through the surface type of inter- and after-condensers connected to steam jets. These results were checked by measuring the diameter of the nozzles and applying the formula for discharge of steam through a nozzle.

The turbine sealing glands were supplied by the recirculation of the condensate, and therefore no account was taken of this quantity in the calculations; the external leakage, however, was accounted for. Condenser leakage on previous tests failed to show any appreciable amount to correct for, so this was taken as zero. External leakages from glands, drips from condensate pump and gland water pump were accounted for.

Steam pressure at the throttle, the inlet pressure, turbine stage pressures and steam temperatures at the throttle and exhaust were all measured with calibrated gages and thermometers. The load carried by the turbine was measured by a Weston portable testing wattmeter previously calibrated. Observations on this instrument were taken at intervals of one-half minute in order to obtain an accurate average. A general switchboard log was kept also, in which observations were entered at five-minute intervals, of the phase voltage and amperes, power factor, and excitation voltage and current. Observations on the turbine operating gages, of steam pressures and temperatures were taken at intervals of five minutes. The weighing of the condensate was at intervals of six minutes.

The manufacturer's guarantees were bettered at every point by nearly 1½ per cent, as shown in Table I.

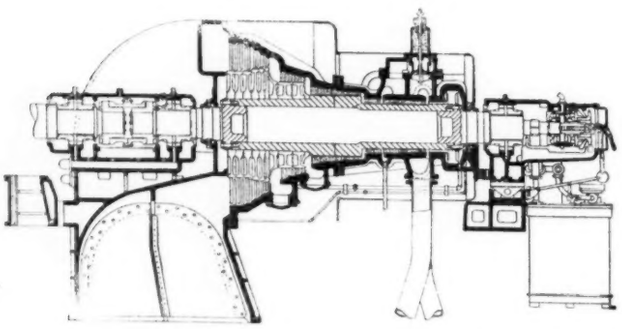


Fig. 1—The valve above the head end of the turbine is the governor-controlled secondary admission valve. The primary valve gear is shown at the right in the headpiece

TABLE II—SUMMARY OF RESULTS OF STEAM CONSUMPTION TESTS OF 15,000 KW. UNIT AT VARIOUS LOADS

Turbine-generator unit, Allis-Chalmers single-flow, reaction, 1,800 r.p.m' 225 lb. per sq.in. gage steam pressure, 125 deg. superheat. Generator, 3-phase. 60-cycle, 11,000-volt.

Date of test, (1926)	April 12	April 13	April 12
Load, fractional	¼	½	Full
Time	A.M. 9:00 P.M. 1:00	A.M. 9:30 P.M. 12.30	P.M. 2.20 P.M. 4.20
Duration, hours	4	3	2
Barometer, in. of mercury	29.50	29.35	29.50
Turbine speed, r.p.m.	1,820	1,820	1,820
Room temperature, deg. F.	85	86	85
Steam pressures:			
At throttle, lb. per sq.in. gage	221.6	220.2	218.6
At high press. extraction nozzle, lb. per sq. in. abs.	18.9	26.8	33.9
At low press. extraction nozzle, lb. per sq. in. abs.	5.3	7.0	9.2
At inlet, lb. per sq.in. gage	104.9	154.2	201.0
At exhaust, in. of mercury, abs.	1.00	1.01	1.02
Steam temperatures:			
At throttle, deg. F.	574.9	556.8	539.0
At exhaust, deg. F.	79.2	79.4	79.6
Saturation temp. at throttle, deg. F.	395.4	395.5	395.0
Superheat at throttle, deg. F.	179.5	161.3	144.0
Condensate:			
Gross condensate, lb. per hr.	89,834	128,400	167,567
Steam to steam-jet air pump, lb. per hr	1,530	1,540	1,800
External leakage, lb. per hr	208	630	318
Net condensate, lb. per. hr.	88,512	127,490	166,085
Electrical data:			
Generator phase voltage, volts	11,779	11,772	11,810
Generator phase current, amperes	468	772	956
Excitation voltage, volts	131.4	128.4	128.9
Excitation current, amperes	337.8	427.4	513.3
Power factor, per cent	79.9	77.3	75.9
Generator output at terminal, kw	7,616.4	11,356.2	14,811.0
Excitation, kw.	44.4	54.8	66.2
Net output of generator, kw.	7,572.0	11,301.4	14,744.8
Generator efficiency, per cent	94.3	95.6	96.3
Output of turbine, b.hp.	10,760	15,840	20,530
Steam consumption corrections:			
For steam pressure, per cent	−0.15	−0.20	−0.51
For superheat, per cent	+4.00	+2.65	+1.40
For vacuum, per cent	0.00	0.00	−0.20
Total corrections, lb.	+3.85	+2.45	+0.69
Net steam to turbine at contract cond. lb. hr.	91,922	130,610	167,220
Test steam rate, lb. kw.-hr.	12.14	11.56	11.34
Guaranteed steam rate, lb-kw.-hr	12.35	11.76	11.46
Margin better than guarantee, per cent	1.70	1.70	1.05
Available energy at throttle, B.t.u. lb	408.5	408.5	408.5
Combined engine efficiency, per cent	68.8	72.3	73.7
Combined thermal efficiency, per cent	22.4	23.75	24.35
Turbine oil temperatures:			
Temperature of oil entering, deg. F.	133	134	134
Temperature leaving thrust brg. deg. F.	139.5	139.2	139.5
Temperature leaving No. 2 & 3 brg. deg. F.	146.3	146.0	146.0
Temperature leaving No. 4 brg., deg. F.	146.2	145.8	145.2
Water temperature through oil cooler:			
In, deg. F.	52.0	46	53.0
Out, deg. F.	62.2	60.5	68.0
Rise, deg. F.	14.2	14.5	15.0
Quantity of water through cooler, g.p.m.	83.0	71.5	72.0
Power lost in bearing through friction, kw.	173.0	152	58

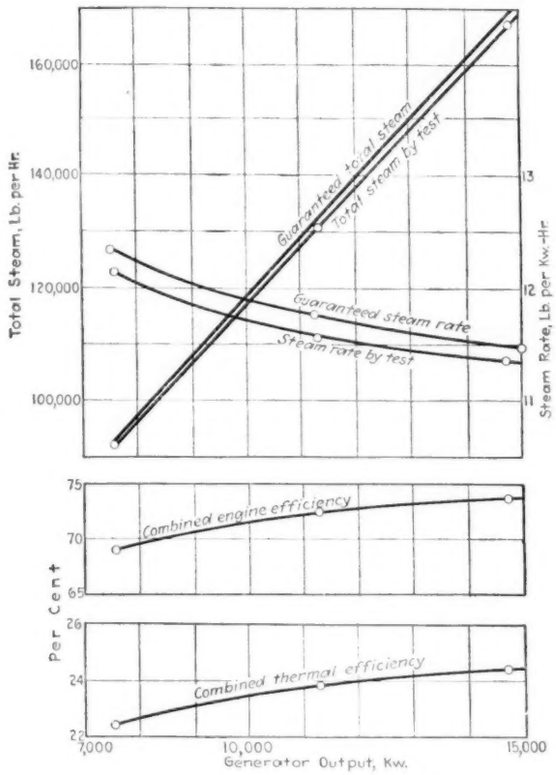


Fig. 2—The test results are better than the guarantees

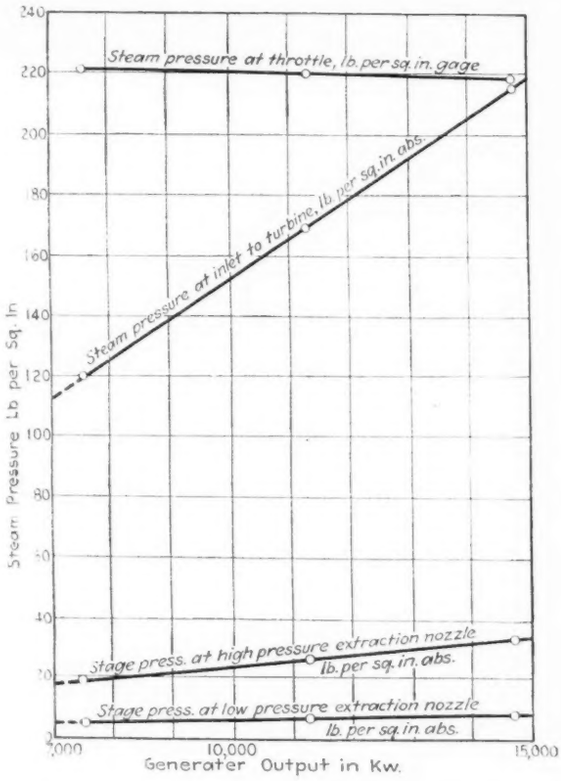

Steam pressure at throttle, lb. per sq. in. gage
Steam pressure at inlet to turbine, lb. per sq. in. abs.
Stage press. at high pressure extraction nozzle lb. per sq. in. abs.
Stage press. at low pressure extraction nozzle lb. per sq. in. abs.
Steam Pressure Lb. per Sq. In.
Generator Output in Kw.

Fig. 3—Straight-line stage pressure curves are characteristic of normal performance

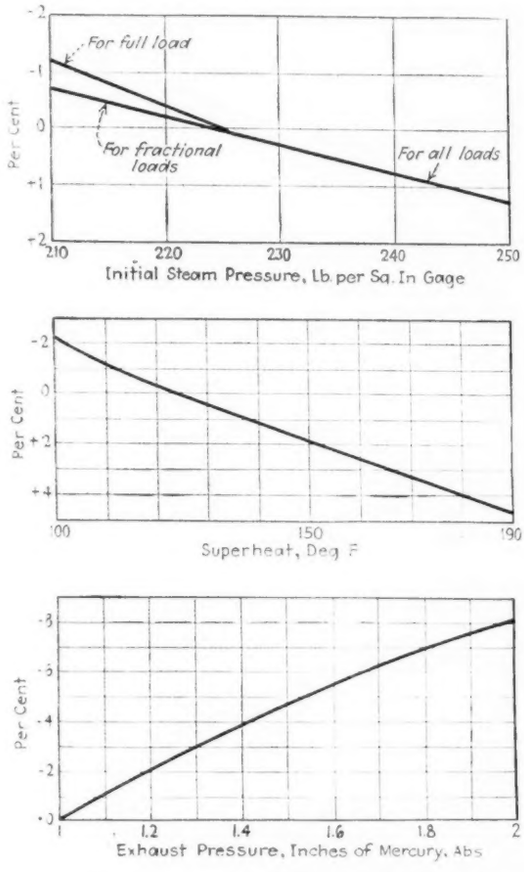

For full load
For fractional loads
For all loads
Per Cent
Initial Steam Pressure, Lb. per Sq. In. Gage
Superheat, Deg. F
Exhaust Pressure, Inches of Mercury, Abs

Fig. 4—Correction curves show the effect of variation in the operating conditions

These curves were furnished by the turbine builder before the contract was signed.

The steam pressure was maintained as close to contract conditions as commercial operation would permit. The steam temperature at the different loads varied considerably owing to the fact that all boilers were connected to one steam header and the characteristic operation of the superheaters on the set of boilers initially installed differ from those on the later set. The exhaust pressure in the condenser was maintained

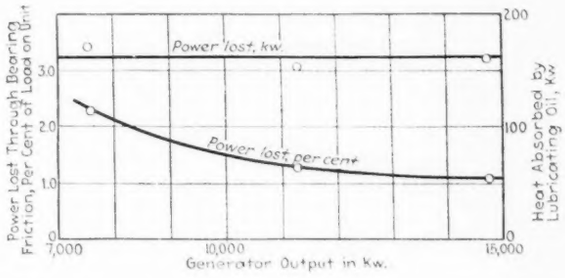

Power lost, kw.
Power lost, per cent
Power Lost Through Bearing Friction, Per Cent of Load on Unit
Heat Absorbed by Lubricating Oil, Kw.
Generator Output in Kw.

Fig. 5—Between 1 and 2 per cent of the output appears as heat in the lubricating oil

at contract conditions by regulating a valve admitting air into the condenser.

Fig. 5 shows the quantity of heat absorbed by the lubricating oil through the bearings and oil pumps. These results were obtained by measuring the quantity and temperature rise of cooling water through the oil coolers. This quantity represents to a fair degree of accuracy the work lost through bearing friction and oil pump friction, of the unit. However, it does not take into consideration the radiation of heat from the bearing pedestals into the engine room. Radiation undoubtedly may be considered very small in this case, as the maximum temperature of the oil was 145 deg. F. and the engine room was at 85 deg. F. The rate of oil circulation through the four bearings of the unit was estimated at 150 gal. per minute.

The unit tested had been in practically continuous commercial service since October, 1925, except for a few shutdowns on Sundays for the purpose of connecting test apparatus and instruments.

Table II gives a complete summary of the results of the tests.

Correction

Fig. 3 on page 474 of the article on "Corrosion—Its Cause and Cure" in the Sept. 28 issue, was properly captioned, "Effect of high temperatures on hydrogen production in boilers." This was erroneously referred to in the text as follows: "Fig. 3, showing the influence of the hydrogen-ion concentration on the corrosive properties of water at 71 and at 104 deg. F., is reproduced from studies by Whitman, Russel and Altrere." The description applies to curves that were omitted from the article to save space.

BEFORE ANY PIECE OF EQUIPMENT is compounded, there must be a definite benefit resulting; otherwise, the increased complication would not be justified. The benefit is different with each class of apparatus. The steam engine is compounded to reduce the loss due to cylinder condensation, the air compressor is compounded to reduce the amount of work required to compress and deliver a given amount of free air, and the steam turbine is compounded for structural reasons.

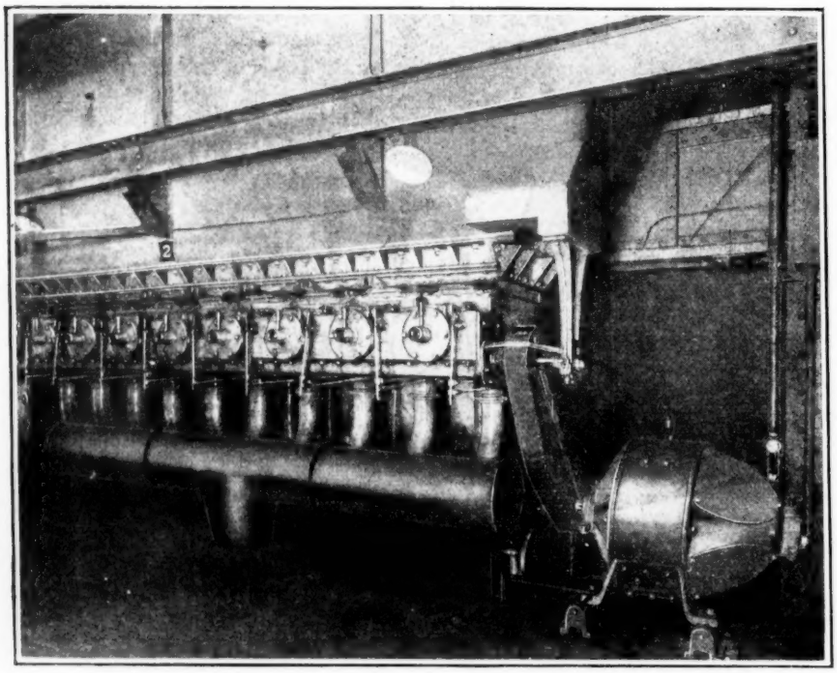
Selecting Motors and Control for Pulverized-Fuel Plants*

Specific Recommendations as to the Types of Motors and Controllers to Use on Various Pieces of Equipment in the Pulverizing and in the Boiler Plant

By M. B. WYMAN
General Engineer, Westinghouse Electric & Manufacturing Company

CONSIDERING the flow of coal through the pulverized-fuel plant and the function that each piece of apparatus performs, the equipment may be roughly divided under two general headings: (1) Coal-handling equipment; (2) pulverized-fuel equipment.

(1) The coal-handling equipment consists of the outside and inside handling equipment and does not differ materially from any stoker plant in the receiving, crushing and conveying methods. Drives for the coal crushers, elevators and conveyors are usually constant-speed applications and squirrel-cage induction motors are applied. For starting under load conditions, drives for this equipment are usually designed for 150 per cent starting torque. The squirrel-cage induction motors are either full-voltage starting or low-voltage starting push-button controlled. In some cases, where it is desired to obtain a high starting torque without taking heavy currents from the line, wound-rotor induction motors, which operate at constant speed, may be used. Such motors operate under extreme dust conditions due to leaks, and in many cases where open conveyors are used it may be economical to inclose these drives totally, since they are usually small enough to permit doing this without self or forced ventilation. Open construction motors with dust-protective features have been applied satisfactorily in many cases. Hence, it can be appreciated that each installation presents a problem as to the best construction to be used.



Group fuel feeder driven by a totally inclosed direct-current motor

(2) The pulverized-fuel equipment proper consists of pulverizing-fuel conveying and feeder equipment. This equipment is located in the station where the suction type of pulverizer mills and the gastight conveyor system eliminate the dust conditions to the extent that the open-type motors may be used almost without restriction.

Coal pulverizer-mill drive is the most severe motor application in the plant, requiring motors of substantial construction and 200 per cent starting torque for starting under load. The squirrel cage induction motor of the open construction with full-voltage starting can be applied. Pulverizer mills may be chain driven or direct connected through reduction gears. To prevent clogging of the mill it is essential that the pulverizer exhauster be operating before the pulverizer mill is started, hence an interlocking arrangement is recommended.

Pulverized-Fuel Conveyors

Powdered fuel is conveyed about the plant in two ways. One method consists of a screw turning in a trough. Such drives are constant-speed applications and motors with good starting torque should be applied. The motors are usually small enough to be totally inclosed economically, which is the practice of several large stations, whereas other stations use the open construction with dust-protective features. Full-voltage starting with push-button control is used.

A second method consists of medium-pressure air. The powdered fuel is fed by a screw into a mixer, where

*Two previous articles on motor and control equipment for pulverized coal plants appeared in Oct. 5th and Oct. 12th issues.

a sufficient volume of air is introduced to carry the fuel in suspension. With this method some means of separating the air from the powdered fuel must be employed, except in the case of the fuel feeders.

In the case of the pulverizer, exhauster-fan air separators are used and the same air is used over and over again, thus preventing dust from that source. With this method of conveying fuel, unless a supply of compressed air is available, special fans must be used. It has been estimated that 1,600 cu.ft. of air per ton of powdered fuel is necessary to convey coal about a modern pulverized-fuel plant. These drives are constant-speed applications, full-voltage starting with push-button control. Since these fans operate under pressure, the atmosphere is free from coal dust and open construction is recommended.

Pulverized-fuel systems require different kinds of fans and blowers. These are all constant-speed applications, except the forced- and induced-draft fans, for which variable-speed wound-rotor induction motors are used with open construction and dust protective features. For all others, squirrel-cage induction motors with full-voltage starting and push-button control are used.

One piece of equipment that has been subject to much discussion, as to its necessity, is the drier. It has been stated that with the screen-type pulverizer mills the moisture content should be reduced to 1 per cent, whereas with the air-separator type of mill the moisture content did not need to be less than 5 per cent, and many coals were found not to exceed this. There are installations with and without driers, but the power input to all preparing and conveying equipment is considerably reduced by the use of a drier as well as a greater heat economy. Where used, the drier exhauster fan may be of the constant- or variable-speed type, depending upon moisture conditions. Squirrel-cage motors with full-voltage starting are employed in the former and wound-rotor induction motor with secondary control in the latter.

Pulverized-Fuel Feeders

In some feeder installations separate motors have been used on each fuel feeder. In other installations group drive for all the feeders serving the same boiler have been used. The former method possibly allows greater control over the distribution of the fuel, but does not result in any greater combustion efficiency than the latter. Where the group drive is used, the feeders are so arranged that cutting out any number of feeders is possible by means of individual clutches.

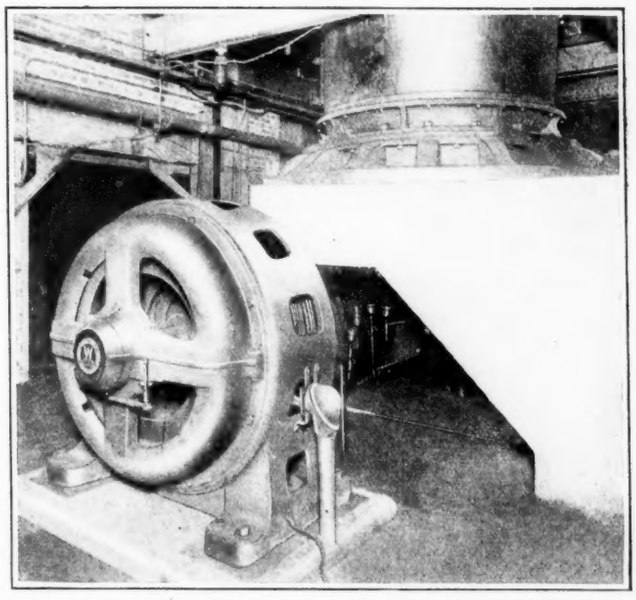
One of the most satisfactory drives for fuel feeders is the direct-current shunt motor with speed control by field, and where applied they should be totally inclosed.

In some installations it has been found desirable to use alternating current for the fuel-feeder drive, in which case the most satisfactory drive is the constant-speed squirrel-cage motor driving through a mechanical variable-speed transmission. Such motors should be of open construction with dust protective features, full-voltage push-button starting.

In some installations where the motors may be so located that they are subjected to excessive dust conditions, it is good practice to inclose them totally.

After the powdered fuel passes through the feeder, air for blowing the fuel into the furnace is required. This air, supplied by a blower, is introduced at the end of the feeder screw and is known as the primary air, comprising 15 per cent of the total air of combustion. This air is usually controlled by means of a damper operated from the same clutch that controls the feeder screw. Since the primary air is only a small percentage of the air of combustion, constant-speed squirrel-cage motors of open construction are applicable for the blower drive. Full-voltage starting, push-button control, interlocked with the fuel feeder drive, is recommended.

The greater part of the air for combustion is introduced through openings in the front wall. Since the furnace is operated under a suction, which the stacks cannot provide in most cases, induced-draft fans are necessary and in some installations forced-draft fans are required. The fan drives are of the variable-speed type, for which the wound-rotor induction motor is a satisfactory drive. However, constant-speed squirrel-cage motors have been applied, the air being controlled by dampers. Open construction motors with dust protective features are recommended, and push-button or automatic control is used.



Pulverizing mill driven by a constant-speed squirrel-cage induction motor

Repeated requests for an electrical interlocking scheme applicable to fuel feeder, forced- and induced-draft fans have been received by the motor manufacturers, and at the present time it is felt that such an arrangement would be more trouble than it is worth. Usually, when the draft is lost an alarm sounds to notify the operator, who immediately shuts down the fuel feeders. If an interlock is to be provided, it is the consensus of opinion that such a device should be a mechanical one operated possibly on the pressure principle.

The conclusions that have been reached as the result of experience in pulverized-fuel plants have been interpreted in the foregoing. Such an interpretation is difficult owing to the diversity of opinion of various operating companies due to their observation of different operating conditions, and it might be emphasized that each installation is a separate engineering problem. The general trend, however, is toward the simplification of the drives and their control, yet maintaining the highest standard of reliability and safety.

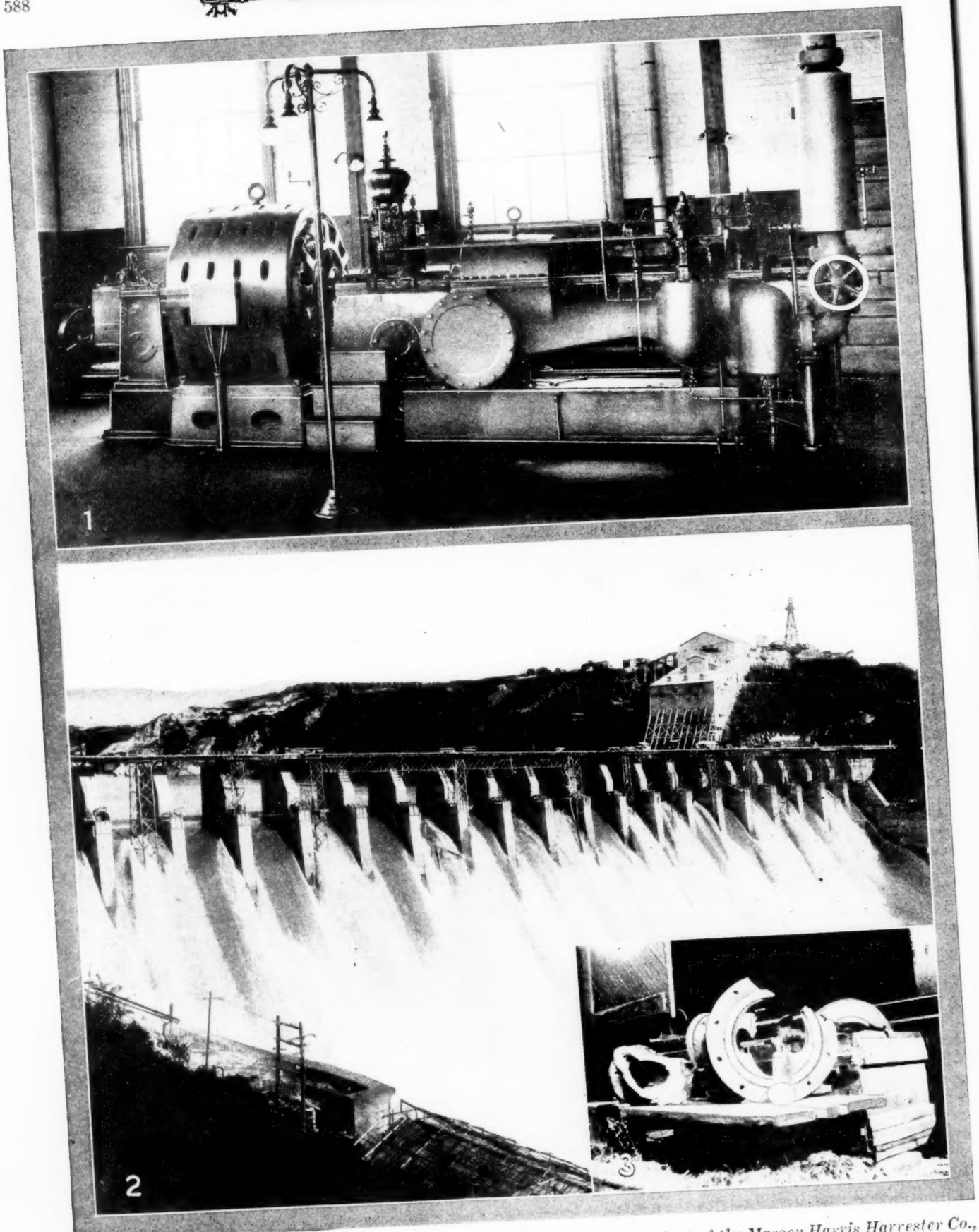


Photo (2) by Ewing Galloway, N. Y.

Fig. 1—This Westinghouse turbine, installed twenty-five years ago in the plant of the Massey Harris Harrester Co., in Batavia, N. Y., is still in use for breakdown service. Fig. 2—Oi dam, largest in the Orient and part of the great Japanese Kiso River development. It rises 190 ft. above stream bed. Fig. 3—A broken stem let the valve into the cylinder of an ammonia compressor at Bay City, Tex. Here are the remains of the cylinder.

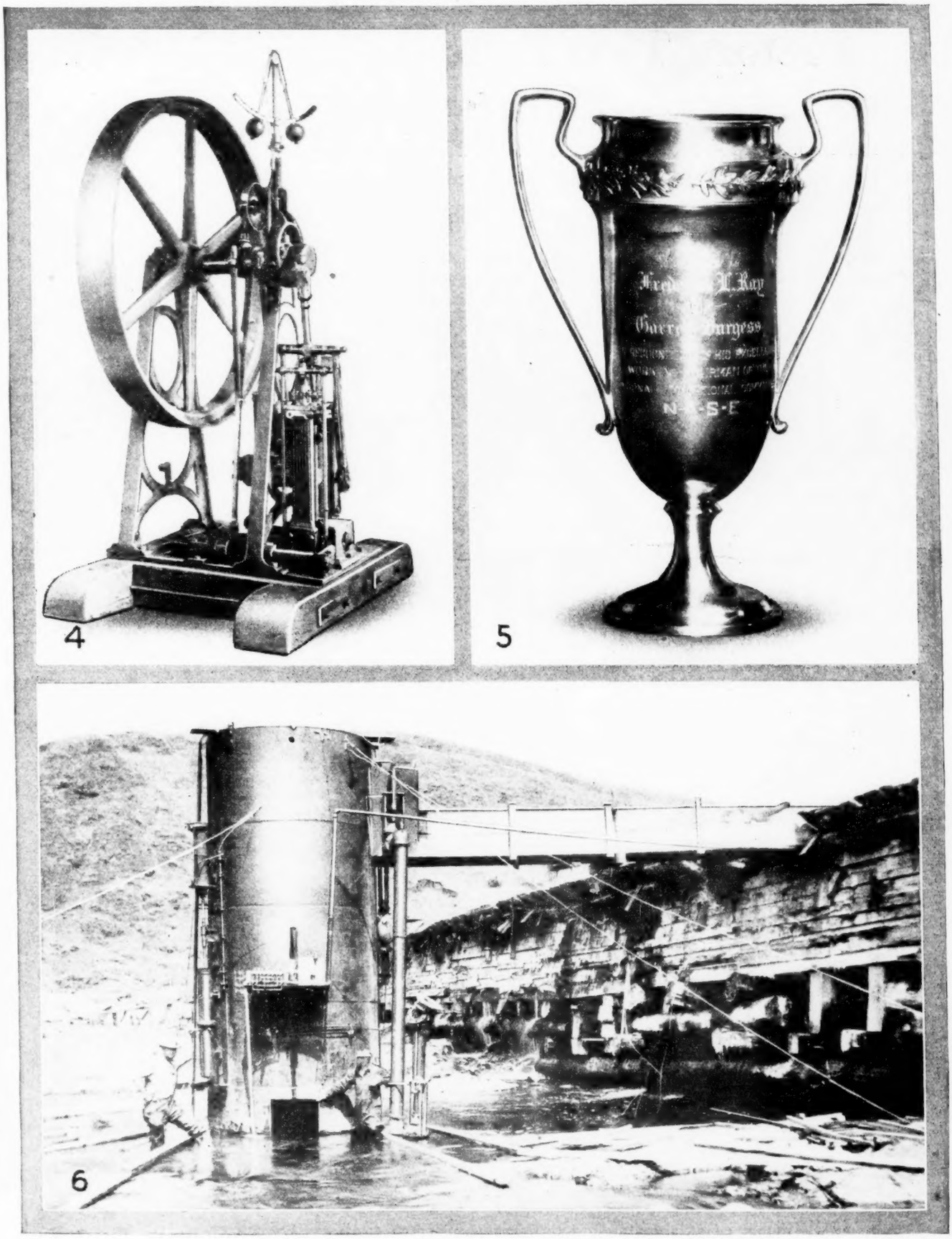


Fig. 4—"Sesqui" displays engine built in 1830 by M. W. Baldwin. It ran in his locomotive works until 1873 and is still in perfect working condition. Fig. 5—Cup presented to Frederick L. Ray, chairman of national educational committee, N.A.S.E., by Garrett Burgess, retiring president, in appreciation of his work. Fig. 6—J. R. Wheeler is here shown experimenting with his new invention, the "fish elevator" on the Umpqua River, near Roseburg, Ore. The aim is to give the fish a lift over the dams instead of making them climb the customary "fish ladders."

Factors That Influence Oil-Engine Maintenance

Maintenance Need Not Be an Uncertain Element—Prestudy of Plant Conditions Permits an Accurate Prediction of Repair Costs

By L. H. MORRISON
Editorial Staff, Power

POSSIBLY, when considering oil-engine power, there is no other single point that causes so much discussion as does the question of maintenance. Data from various existing plants may be cited as proof of low or high costs, without obtaining any agreement in views.

The foundation for this uncertainty lies in the wide variation in the reported costs. This discrepancy is sometimes used as ground for a claim that the behavior of an oil engine cannot be predetermined and that each unit has an individuality of its own.

The fact of the case is that an oil engine of a given make is far from being temperamental and will behave practically the same as any other engine of this make if operated under the same conditions. With the same load the maintenance of the two engines will not show perceptible difference. It is the widely varying conditions existing in oil-engine plants that are responsible for the variation in repair.

Handling Maintenance

Maintenance, so some claim, should be the current repair cost, and as a result of this wrong thinking, the item during the first few years is extremely low. In time the engine begins to show evidences of wear and must undergo overhauling; this boosts the current maintenance item to a high figure, which is cited at times to prove the unsuitability of the oil engine. Maintenance should be handled somewhat as is depreciation, and a set sum should be set aside each year to which the cost of current repairs should be assessed, and the remainder used to cover the overhauling. This is a more equitable procedure, for the overhauling is due to wear extending over several years.

If intelligent consideration be given to the service condition under which an engine is to operate, an engineer thoroughly versed in oil engines can accurately predict the expense to be entailed by the maintenance of the machines. The misfortune is that too frequently the well-informed man is missing from those engaged in the discussion. While there are minor influences, the chief factors that affect oil-engine maintenance may be listed as: (1) Capacity factor; (2) loading; (3) cooling water; (4) fuel; (5) air conditions; (6) engineers' skill; (7) installation conditions; (8) engine design.

These factors are so interrelated that they cannot be totally separated in a plant study. Nevertheless, each brings to bear its separate influence, and an unfavorable condition of one may destroy the advantages inherent in the excellent standing of all other items.

The capacity factor is of importance inasmuch as the continuous loading of an engine to 90 per cent of its rating is more beneficial than its operation at less than half load. On low loads the governor regulation frequently is poor; this causes the fuel charges to the cylinders to vary over wide limits, and the temperature stresses are by no means as acceptable as when the loading is uniform. In certain designs this governor hunting leads to excessive carbon formation in the cylinder, followed by gumming of the piston rings, ring breakage and loss of compression. The deposit of unburnt carbon increases, and to keep the unit in service, the unskilled engineer increases the lubrication oil feed, which in turn increases the ring trouble.

Determining the Best Loading

The term "capacity factor" is hardly the correct one to use, since an engine might have a widely varying load and still show a capacity factor of, say, 70 or 80 per cent; momentarily, loads might be as high as 1½ load followed by ½ rating loads. Experience indicates that the best uniform load is 85 per cent of rating when the effect on maintenance costs per horsepower-hour is the sole criterion. Higher loading is not so favorable, and as the loading decreases engine results become less favorable. Using 85 per cent capacity factor with a constant loading as the ideal, one can conclude that as the product of the expression (max. load — min. load) × capacity factor increases, the maintenance increases, for any given capacity factor. As example, a maximum load of 110 per cent rating and a minimum load of 25 per

Fig. 1—An open cooling system is satisfactory only where the water is non-scaling

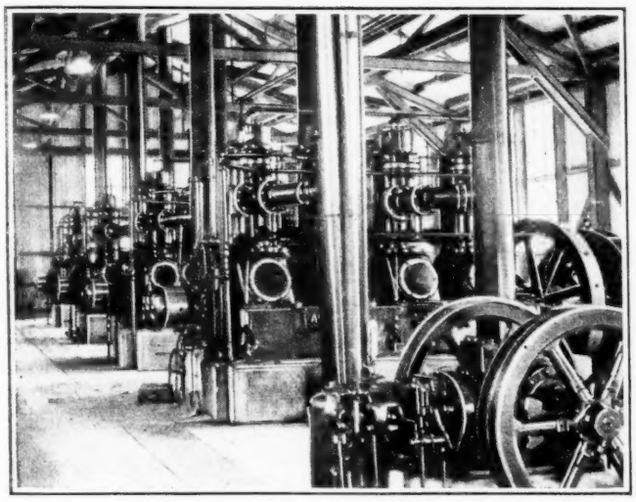


Fig. 2—Engines in rock-crushing plant require air cleaners

cent with a capacity factor of 0.85 gives (110 — 25) × 85 = 7,225, while 90 per cent maximum and 40 per cent minimum with an average loading of 0.85 gives (90 — 40) × 85 = 4,250, indicating that the second set of load conditions are the better.

A further conclusion is that with the same difference between maximum and minimum load, the maintenance per horsepower-hour increases with a decrease in the capacity factor below 85 per cent.

A general statement that accords fairly closely with actual records, is that the total yearly maintenance at any capacity factor is decreased from the costs at 85 per cent capacity factor by one-half the per cent decrease in the capacity factor from 85.

Poor Cooling Water

Too much emphasis cannot be placed on the distressing results brought about by a poor cooling-water system. Some oil-engine purchasers fail to appreciate the necessity of non-scaling water and too frequently make use of surface water containing much organic matter or well water holding large amounts of scale-forming material. Concededly, a closed system wherein pure water is circulated and is cooled by the flow of raw water over a set of coils, costs more than an atmospheric cooling tower, but this is offset by the total absence of the engine trouble ordinarily caused by scaly jackets. If a scale-forming water be used, the maintenance costs will show a large increase, especially in the item of cylinder liners. The actual loss due to a poor water depends upon the frequency of scaling and upon the engine load. A lightly loaded unit will not suffer from poor jacket cooling as one carrying full load. In fact, if the jacket be badly scaled, the engine seldom is able to reach its rating.

The character of the fuel to be burned may increase the labor required to keep the engine in operating condition, but seldom is a breakage or the necessity for a renewal of a part directly traceable to bad oil. Oil with a heavy hard asphalt content will cause carbon deposits in the cylinder and may clog up the pump and oil lines, but will seldom cause liner wear. The amount of ash in oils is so low that it can hardly be blamed for the wear of any part.

Labor and time consumed in cleaning engine valves depend not so much on the grade of fuel as on the method used to heat and filter the oil. Consequently, in a plant where operation is continuous for six days, with no stand-by unit, it is not advisable to use the cheapest oil unless there be a large price differential or excellent filtering equipment.

Air conditions are considered negligible factors, but experience has shown that dust drawn in with the air charge is capable of rapidly cutting cylinder liners, valve and compressor parts. Around quarries, cement mills, ore crushers and brick plants the air is charged with particles of grit and sand. It is almost suicidal from the viewpoint of engine life, to permit such particles to enter the engine. Air filters should always be used when grit is likely to be encountered. Engineers should not forget that in any sandy locality a strong breeze will stir up sufficient light sand to make it disagreeable to even a human being, equipped as he is with a nasal air filter, and will speedily ruin an engine's valves unless the sand be separated out of the air.

A Good Engineer Is Needed

Regardless of the utterances of ill-advised enthusiasts, an oil engine requires the attention of an intelligent operator, who by reason of his ability necessarily is not everywhere available at a low wage. The man need not be a machinist, but should have had enough experience with power machinery to have acquired the knack of how to make repairs and adjustments. Above all else he should possess what is commonly termed "horse sense." The garage is not the place where such a man is to be found, for automobile mechanics are notoriously poor workmen and with all their pose, know but little of the how and why of things. Possession of a good engineer automatically cuts probable maintenance costs in half. In addition, a heavier fuel may be burned without ill effect and the saving will more than cover the pay differential of a high-grade man.

Engine design has little influence upon fuel consumption, but may be reflected in the reliability and maintenance records. All other things being equal,

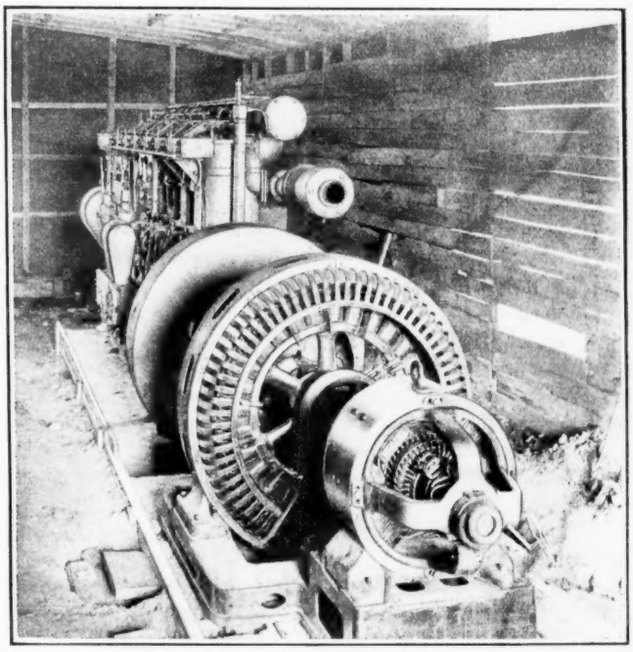


Fig. 3—A good engine deserves a good building

simplicity is desirable, but it is a mistake to assume that the engine of the fewest mechanical parts is necessarily the most reliable. In determining the value of the simplicity factor, one must depend upon known records of existing installations. Certainly, there may be great differences in the repair costs of two types of engines. One design may be satisfactory for 10-hour service at ¾ load, yet be unable to withstand the severity of constant 24-hour operation at ¾ or full load.

The several factors to be considered in comparing probable maintenance costs have been considered briefly, but no answer has been given to the question, What will be the maintenance costs? The lowest probable cost may be taken as 50 cents per horsepower per year. This requires the best operating skill, good design, satisfactory loading, and all others of the several factors mentioned must be at their optimum values. If the loading is unfavorable, for example, full load on continuous runs, the repair expense may run as high as $5 per horsepower per year if the plant does not have every advantage. With anything but the worst of conditions the item should not exceed one-half mill per horsepower-hour and in most plants will be found to be not over one-tenth of the fuel cost.

How To Prevent Lead Poisoning When Working on Storage Batteries

In the routine care of a lead storage battery in service there is no danger to health, but at such times as the battery parts, especially the plates and the sediment, have to be handled in large quantities, the possibility of lead poisoning should be kept in mind and guarded against.

Lead poisoning may result from the introduction of particles of lead dust or oxide into the system through the mouth or nose, or it may occur from breathing the fumes from molten lead, as when burning the plates into position in the tanks. The salts which sometimes form on the copper and iron work should also be kept out of the system.

To guard against the possibility of lead poisoning, the following precautions and rules, given in the "Manual of Storage Battery Practice" of the Association of Edison Illuminating Companies, should be observed.

1. Do not go to work on an empty stomach; this is especially important, as the stomach, when empty, readily absorbs lead.
2. Do not put the fingers in the mouth or take food while at work.
3. Keep the finger nails cut short and clean.
4. Do not chew tobacco while at work. In handling tobacco, the lead oxides are carried from the hands to the mouth. Chewing tobacco does not prevent the user from swallowing the lead, as is often believed.
5. When leaving work and before eating, wash the face, hands and arms with soap, and thoroughly cleanse the mouth, nose and finger nails.
6. Do not eat lunch in the same room in which there is lead dust.
7. Drink plenty of good milk; it is a valuable preventive of lead poisoning.
8. Whenever in the least constipated, take a dose of epsom salts; it will do no harm if this is taken regularly. It is exceedingly important that the bowels be kept in good condition.
9. Take a bath frequently; cleanliness is the best preventive of lead poisoning.
10. Keep your teeth clean and in good condition. Brush them morning and night. Have your dentist examine them regularly.
11. Working clothes should be left at the place of work.
12. It is better not to wear a mustache or beard; they collect the dust. If worn, they should be cut short and kept clean. Also a cap should be worn to cover the hair.
13. When sweeping, always dampen the floor to prevent raising dust.
14. When working where there is lead dust, wear a respirator.
15. Do not drink alcoholic liquors while at work, or better, avoid their use entirely. Whiskey does not cut the lead in the system, as some believe. Alcohol always weakens the system and makes it more susceptible to lead poisoning.
16. In work where lead comes in contact with the hands, wear gloves as much as possible and wash and dry them each day when used.
17. The wearing of goggles will prevent the splashing of wet sediment or acid in the eyes when repairing battery cells.
18. When melting lead with a hydrogen flame, as when burning plates to busbars or repairing tank linings, the fumes given off may be blown away from the man operating the flame by a suitably directed stream of air (the air supply for the flame may be tapped for this purpose).

The usual symptoms of lead poisoning are bluing or darkening of the gums, indigestion, colic, constipation, loss of appetite and muscular pains and, in the later stages, muscular weakness and paralysis. *Indorsed by the American Museum of Safety.*

Power Plant as a Separate Manufacturing Unit

In many industries the power plant should be treated as a separate manufacturing unit and its accounts so set up on the books of the company that its services could then be charged out to the different departments on a fair basis of apportionment to cover the actual costs of such services. With this method of accounting, the changing conditions in the factory would contribute the proper share of added cost or reduced cost of the several services that the power plant provides. In this way many useless expenditures for new equipment might be headed off, and on the other hand, needed equipment could be better selected and would be placed where it would yield the greatest profit.

That boiler plant is the best which produces a given quantity of steam at the lowest cost per one thousand pounds of steam made; and that generating plant is best which can take a given quantity of steam and from such steam extract the greatest amount of heat and power.

If these things are not measured and properly accounted for, both as to their costs and their utilization, it is evident that erroneous conclusions are bound to be drawn as to the best method of getting these indispensable services of heat, power and light.—*From Report of Power Plant Cost Committee, N.A.S.E.*

Some Unusual Experiences

observed by boiler and flywheel inspectors

By WILLIAM H. BOEHM

THIS is the second collection of incidents related by Mr. Boehm, who is vice-president in charge of boiler, engine and flywheel insurance of The Fidelity and Casualty Company of New York. The first, which appeared in the Aug. 31 issue, showed how little things, when neglected, often lead to disastrous accidents.—Editor.

AN INSURANCE inspector went into the engine room of a Southern cotton mill for the purpose of making a flywheel inspection. He met the venerable chief engineer, and could not help noticing that whenever anything was said about engine governors, the chief backed up against the door jamb and began to scratch his back. The chief noticed the expression of curiosity on the inspector's face, apologized for having to scratch his back so often, and said that the mere mention of engine governors made him so uncomfortable that he had to do it. When a small boy he wanted to be an engineer. His father at first opposed his ambition, but subsequently agreed, got him a job as an oiler, and told the boy's new boss to give him the dirtiest job he had about the place. Oiling engines is dirty enough, but, this particular engine had under it a galvanized iron tray to catch oil drippings. While under the engine, wiping out this tray, the boy raised his back against the miter gears of the governor. Instantly his clothing was gripped by the teeth of the gears, and he was whirled nearly a complete revolution before his clothing gave way and freed him. Meanwhile, the governor belt began to slip and the engine started to race. The boy jumped to the throttle and shut down the engine. It was this boyish experience of the old chief that made him rub his back against door casings every time anybody mentioned steam-engine governors.

Wiping Cloth Blocked Governor

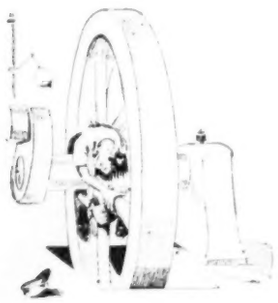
The flywheel on an engine in a boxboard factory burst, badly damaged the engine, a considerable amount of other machinery, and killing the oiler. Several theories were advanced as to the cause of the accident; but the real cause was not discovered until several days later when an insurance adjuster was investigating. He found that a handful of cloth had become wedged so tightly between the side of the governor pulley and the side of the engine frame that the governor pulley could hardly be revolved even by the use of a crowbar. This blocked the governor pulley and caused the engine to race. The man killed in the accident had used this handful of cloth to wipe around the engine.

A large dry kiln in a New Jersey oil-cloth factory was used for drying coated oil cloth. Also in this factory there was a fast-running belt that accumulated an unusual amount of static electricity—so much that if one stood under the belt, and raised his hand close to it, blue streams of electricity would flow to the finger tips. A workman who had on rubber shoes stood directly below this belt long enough to obtain a heavy charge of static. He then walked to the oil-cloth drying kiln, touched a metal door fastener and discharged the electricity that he had accumulated. The resulting spark ignited the combustible vapors coming from the coated oil cloth and caused an explosion that wrecked the dry kiln. The dry kiln was rebuilt, the new construction being much the same as it was before the accident occurred. Now this accident happened some 28 years ago, and curiously enough, just recently at the same plant there was a recurrence of exactly the same accident caused in exactly the same way.

A heavy-duty engine in a rolling mill was equipped with a special speed-limit device additional to the usual governor and stop, and there were push buttons located at convenient places for the purpose of shutting down the engine in case of danger. The speed-limit device was operated by a weight attached to a cable running over a pulley and down to a dashpot on the stem of which was mounted a sprocket wheel; a chain ran over this wheel and a corresponding sprocket on the throttle valve stem. During the noon hour, while the engineer was seated on a bench eating his lunch, the engine started to race. He jumped to the engine, because he was closer to it than to any push button. To shut it down he had to spring the latch that released the weight operating the sprockets that closed the throttle. To reach the latch he had to thrust his arm between the two parts of the sprocket chain. His clothing caught between the sprocket chain and one of the sprocket wheels. A helper ran to his assistance, and while tugging to get him free, the big flywheel went to pieces. The mill was wrecked. One section of the wheel was hurled through the side wall and landed on a railroad track two hundred feet away. Another piece went through the roof and so high in the air that, in falling, it buried itself in the ground almost out of sight. The two men were uninjured. They were just out of range, being slightly to one side of the plane of the wheel.

A compound condensing Corliss engine with a 20-ft.

flywheel operating in an electric-light plant, had a leaky throttle valve. The flywheel ran below the floor level in a pit. One day the assistant engineer dropped a monkey wrench into the flywheel. He leaned heavily on the end of a spoke while trying to reach the wrench. This started the engine and the wheel began to revolve.



Being off balance he could save himself only by jumping into the wheel and throwing his legs and arms around the spoke. The spokes were varnished and greasy; when the spoke was down he slid to the rim; when it was up he slid to the hub, and he began crying lustily for help. The chief engineer heard him, knew the throttle was leaky, sensed his plight and ran to the boiler room, where he shut off the steam. When he got back to the engine it had stopped, and his assistant was climbing out of the wheel, white as a sheet. The only damage was to his watch, which was still attached to its chain, but beaten to pieces by its impact against the wheel. The throttle valve was promptly repaired.

A boiler exploded while an inspector was inside examining it. This seems incredible, but the inspector was vigorously hammer testing the boiler when he heard a loud report. He climbed out, expecting to see the result of some violent explosion. He saw nothing, and no one else seemed to be disturbed. He climbed back into the boiler and then to his amazement, discovered that the bottom sheet had ruptured throughout its entire length. The boiler was of the locomotive type; it had been repaired by the oxyacetylene process. This had left in it locked-up temperature strains so severe that only light hammer blows were required to cause the rupture that had occurred. It is believed that this is the only case on record where a boiler exploded while the inspector was inside of it.

When a boiler exploded in a cotton gin on a Southern plantation, the negro fireman went up with it. Fortunately, he landed on a pile of cotton seed and, after

two months spent in the hospital, was able to be about his duties again. When a boiler inspector went to examine the new boiler, he found the old negro fireman in attendance. He asked him whether it was true that he went up with the old boiler. The fireman said, "Yessah boss, it am true, and if it warn't for the pile of cotton seed I sure would be a dead niggah." "Sam," said the inspector, "how high up in the air did you go?" The fireman answered, "I don' know, boss." "Well," said the inspector, "how long do you think you were up in the air?" The fireman answered, "I tell you the truth boss, I don' 'zactly know because I forgot to look at my watch." I am unable to verify this story about the fireman, but have related it just as it was told to me.

An inspector, desiring to examine an engine, tried to time his visit so that he could make the inspection while it was running and just after it would be shut down. But he was just a little late, and as he entered one door of the engine room, the engineer was going out the other. He glanced at the engine and to his amazement saw that the flywheel was at rest while the governor was revolving. He ran after the engineer, but upon returning with him found that the governor had stopped. A thorough investigation was made and it was found that a setscrew in one of the miter gears of the governor had worked loose, and that the momentum of the governor weights was sufficient to continue the operation of the governor after the engine had been shut down. The engineer was very appreciative of this discovery because he knew that if it had not been discovered a bad flywheel wreck might have occurred.

Steam-Jet Ash Conveyors

By C. G. Alexander

Steam-jet ash conveyors have been in use for many years. They are simple to operate, take little room and may be used in locations where no other system is applicable.

Certain of these installations have been open to criticism due to excessive steam consumption. This may have been caused by faulty steam-nozzle design and location or by improper and irregular methods of feeding the ashes. The wear on certain parts of the conveyor piping, particularly at bends and turns, has been rapid in some plants, and this has resulted in excessive maintenance. Dust leaks from pipe joints and from the discharge ash receivers have created troublesome nuisances which were difficult to overcome.

These difficulties are all susceptible to satisfactory solutions when properly approached. Nozzles designed in accord with modern theory and made of wear-resisting materials should materially reduce steam consumption when coupled with further studies to determine the best nozzle location and the proper method of introducing the ash. It should be possible to find better materials to withstand wear at bends and turns. Improved design and better construction would eliminate the dust nuisance, or a washer may be placed on the ash bin vent.

This simple ash-conveying system has not had the wide use that it may deserve owing to the attempts in the past to apply standardized equipment to every type of plant. Operating results indicate that this cannot be done successfully and that every plant should be designed as an individual problem. With this plan adopted by concerns having a competent engineering force, the steam-jet ash conveyor may be expected to find a wider application than it does at present.

The Limiting Factor in the size of large electric generators is the ability to make and ship a forging sufficiently large for the generator rotor. The limit is approximately 220,000 lb. While the rotor might be made in sections, it is impracticable to assemble such a structure in the field, and the difficulty of handling and shipment would still have to be met. This leads to a limiting size for a single generator in the neighborhood of 75,000 kw. in the present state of the art. It is quite possible to design a machine for 100,000 kw., but the rotor would weigh approximately 400,000 lb. and would be too heavy to ship or to handle with present machine-tool equipment. Sectionalizing the structure would reduce the weight of the individual forgings, but this would not help in machining, shipping and erecting.

*Boiler Feed-Water Purification—XVI**

Standard Methods of Water Analysis

This, the Last Article of the Feed-Water Series, Is One that You Will Want to Read and File for Future Reference. It Gives Clear and Specific Instructions for Those Simple Chemical Tests of Feed Water Which Are Commonly Made by the Power-Plant Staff

BY SHEPPARD T. POWELL
Consulting Chemical Engineer, Baltimore, Md.

EFFICIENT control of feed-water purification depends upon accurate routine testing of the water entering the feed-water cycle and water that has concentrated in the boilers. The kind of tests necessary and the frequency of testing will depend upon the character of the raw water, the type of purification system, the method of operation of the boilers and many other items.

Boiler-feed treatment is a relatively simple procedure from a theoretical viewpoint. In practice, however, the problems encountered are frequently complicated and involved. There are certain minor routine tests of water requiring no special chemical training, which may be made by plant operators. Tests of this kind, when properly interpreted, are of the utmost value in the proper conditioning of feed water. These records are invaluable for plant control, but should not be considered as a substitute for the more scientific and accurate testing by persons who are specially qualified in this field.

Routine plant tests serve as a guide in determining the daily efficiency of water-purification systems, in controlling condenser leakage and regulating boiler blowdowns. It is extremely difficult to lay down any set of standards for the desired quality of feed water or boiler water concentrations, since so many factors influence the results. A definite concentration of alkalinity, sulphates or other constituents which may be safe under one set of conditions may be highly objectionable elsewhere. These values should be established by local conditions and controlled by careful and accurate routine tests.

There are numerous methods for testing water which up to the present time have not been standardized[1] for feed-water control. Not only do the methods of testing differ, but the reporting of results is not uniform. This latter fact has led to much confusion. Investigators report their findings in parts per 100,000, parts per million, grains per U. S. gallon and in pounds per thousand gallons. The majority of water-softening equipment is calibrated to read in grains per gallon, while the analytical data are reported in other forms. The following tests are all calculated to read in parts per million. These may be converted to grains per U. S. gallon by multiplying by 0.0583.

Test I—Test for Total Alkalinity

The alkalinity of a water indicates the presence of certain salts in solution, which have the power to neutralize acids. The alkaline salts may be present in a number of different forms. The ones usually present in boiler feed waters are known as carbonates, bicarbonates and hydrates. One or two of these forms of alkalinity may be present in a water, or there may be a change from one form to another during chemical treatment or under the influence of heat.

It is desirable for the plant engineer to know, not only the amount of total alkalinity of his boiler water, but also the amount of each kind of alkalinity. He should know what parts of the alkalinity in the water tested are present as carbonate, bicarbonate and hydrate alkalinity. These tests are comparatively simple and may be readily made with a fair degree of accuracy by any intelligent operator.

Total alkalinity, as the term implies, means the total amount of all forms of alkaline salts in solution in the water. Place 100[2] c.c. of the water to be tested in a porcelain evaporating dish, having a capacity of 150 to 200 c.c. Add about one cubic centimeter (2 to 4 drops) of methyl orange indicator, which is referred to later as *M*, and stir with a glass rod. The color of the water after adding the indicator will be yellow if the water is alkaline; if it turns red, the water under test is acid. When the water is alkaline, add one-fiftieth normal sulphuric acid (marked $\frac{N}{50}\,H_2SO_4$) drop by drop from a glass burette, that is graduated to read in tenths of cubic centimeters, stirring the water after each addition of acid until it changes from yellow to a faint pink, then read the burette and determine how much acid was used to bring about this change. Each cubic centimeter of acid used is equivalent to 10 parts per million of alkalinity.

*Previous installments have covered the following subjects: July 6, "Natural Waters and Their Impurities"; July 13, "Getting Rid of Impurities by Sedimentation and Coagulation"; July 20, "Filtration by Gravity and Pressure Filters"; July 27, "Softening Water by Chemicals"; Aug. 3, "Hot Process Continuous Softeners"; Aug. 10, "Zeolites Explained"; Aug. 17, "Where Zeolites Fit In"; Aug. 24, "Boiler Compounds"; Aug. 31, "Priming and Foaming"; Sept. 7, "Embrittlement—What Causes It"; Sept. 14, "Evaporators, Their Design and Operation"; Sept. 21, "Getting Rid of Dissolved Gases by Deaëration"; Sept. 28, "Corrosion—Its Cause and Cure"; Oct. 5, "Deconcentrators and Continuous Blowdown"; Oct. 12, "Feed Water Heaters and Miscellaneous Treatment."

[1]The feed-water studies committee is now studying the standardization of water analysis for boiler feed-water use.

[2]The amount of water employed for this or other tests may be reduced, but the proper factor should be used to be comparable with the calculation given.

Example: Suppose 100 c.c. of water requires 4.2 c.c. of acid, then $4.2 \times 10 = 42$ parts per million of total alkalinity.

Test II—Test for Carbonate, Bicarbonate and Hydrate Alkalinity

To determine carbonate, bicarbonate and hydrate alkalinity, a second test must be made, which is carried on as follows:

Place 100 c.c. of the water to be tested in a porcelain evaporating dish, and add a few drops of phenolphthalein indicator, which is referred to later as *P*. If the color of the water remains white after adding the indicator *P*, all the total alkalinity read in the test with the *M* indicator is present as bicarbonates. If the water turns red after the addition of the phenolphthalein indicator, add $\frac{N}{50}$ H_2SO_4 as in the test for total alkalinity and determine how much acid is required to change the color from red back to white.

Example: Suppose 2.7 c.c. were required to bring about this change, then the *P* alkalinity would be $2.7 \times 10 = 27$ parts per million.

The various forms of alkalinity may be calculated from the accompanying table:

FORMULAS FOR COMPUTING THE VARIOUS FORMS OF ALKALINITY PRESENT

	Bicarbonates	Carbonates	Hydrates
$P = 0$	M	0	0
P less than $\frac{1}{2}$ M	$M - 2P$	$2P$	0
$P = \frac{1}{2}$ M	0	$2P$	0
P greater than $\frac{1}{2}$ M	0	$2(M - P)$	$2P - M$
$P = M$	0	0	M

Example: Suppose *M* alkalinity = 42 parts per million, and *P* alkalinity = 27 parts per million. One-half of 42 = 21. The *P* alkalinity is greater than $\frac{1}{2}$ *M*, therefore there is no bicarbonate alkalinity and the alkalinity is caused by carbonates and hydrates which, according to the figures given in the table, would be $2(M - P) = 2(42 - 27) = 30$ parts per million of carbonate alkalinity and $2P - M = 2 \times 27 - 42 = 12$ parts per million of hydrate alkalinity.

Test III—Hydrogen-ion Concentration

The hydrogen-ion concentration of a water is a measure of its alkalinity or acidity. This test differs from the ordinary alkalinity or acidity tests in that it is not only more delicate, but is indicative of conditions that are not shown by these tests. The test is important in routine practice and is sufficiently simple to be made by plant operators who have no special training in chemistry. The test may be made by electrometric or colorimetric methods.

To determine the hydrogen-ion concentration by the colorimetric method, 10 c.c. of water to be tested are placed in a test tube and $\frac{1}{2}$ c.c. of a prepared dye (indicator) is added. The treated sample is allowed to stand for five minutes and the color produced is matched against one of the color standards[3] which have been prepared by the same indicator as used in the test. The number of the standard color tube that matches the treated sample of water is the hydrogen-ion concentration number. The standards are numbered from 0 to 14.0. The tubes above 7.0 may be considered within the alkaline range and those below 7.0 within the acid range.

[3]Standards and indicators may be obtained from any of the chemical supply houses.

Example I: Ten cubic centimeters of water are treated with $\frac{1}{2}$ c.c. of Brom-thymol blue indicator and allowed to stand five minutes. The color of the water at the end of this time is blue and matches the Brom-thymol blue standard tube marked 7.4. The hydrogen-ion concentration is therefore 7.4.

Example II: Ten cubic centimeters of water are treated as above and the color produced is deep yellow. The Brom-thymol blue standards range from yellowish green to deep blue. This sample, however, is a deeper yellow than the lowest color tube in this set, which we may say is 6.4. This indicates that the acidity of the water is beyond the range of the Brom-thymol blue standards. The test should then be repeated, using the color indicator which may match the color standard within the range below 6.4. This procedure is repeated until the water, when treated by one of the series of prepared dyes, falls within a color range that may be matched against the prepared standards.

The foregoing test is less accurate than the electrometric method. The latter method also is desirable in many instances, since a permanent record may be obtained by the use of recording devices.

Test IV—Chlorides

The term "chlorides" is used to express the combination of chlorine with other elements forming salts that are comparatively stable and not easily broken up under ordinary conditions. The term "chlorides" is to be distinguished from "chlorine" such as liquid chlorine used extensively for the sterilization of public water supplies. The chlorides commonly present in water are sodium chloride (common salt) magnesium chloride and potassium chloride.

The test for chlorides is performed in the following manner: Place 100 c.c. of water to be tested in a 150-c.c. porcelain evaporating dish, add 1 c.c. of potassium chromate indicator. If water is acid, sample should be neutralized. The color of the water will be yellow. Add the standard silver-nitrate solution from a burette drop by drop until the color of the water changes from yellow to a faint red. When this change takes place, determine how much of the silver-nitrate solution has been used and multiply the number of cubic centimeters of solution by ten and the result will be the chlorides present in water expressed in parts per million.

Example: Amount of silver nitrate solution used, 10.8 c.c. $10.8 \times 10 = 108$ parts per million of chlorides.

Test V—Dissolved Oxygen

The presence of oxygen in water used for boiler feed is objectionable, since it increases the corrosive properties of the supply. It is essential in steam-station operation that the dissolved oxygen content of the feed water be kept as low as possible. In order to control the dissolved oxygen, tests should be made at frequent intervals. This test is not particularly difficult and may be carried out by an operator who has not had special training in chemistry, provided the sample is taken carefully and the test is made with strict adherence to the instructions.

The solutions required are as follows:

1. *Manganous Sulphate:* Dissolve 480 grams of manganous sulphate in one liter of distilled water.

2. *Alkaline Potassium Iodide:* Dissolve 700 grams of potassium hydrate and 150 grams potassium iodide in distilled water and dilute the solution to one liter.

3. *Hydrochloric Acid:* Concentrated (specific gravity 1.18 to 1.19).

4. *Sodium Thiosulphate:* One-fortieth normal $\left(\frac{N}{40}\right)$.

(This solution should be carefully prepared and checked by a chemist, as should the other normal solutions.)

5. *Starch Solution:* Dissolve about one gram of Litner's soluble starch in 100 c.c. of distilled water to make a thin paste and then pour into 900 c.c. of boiling distilled water and continue boiling for four or five minutes. When cold add a few drops of chloroform and keep this solution in a glass stoppered bottle in a dark cool place. Starch solution does not keep well and should be made up fresh every week or ten days.

The bottle in which the sample is collected should be a glass-stoppered tincture bottle of good quality and have a capacity of from 250 to 270 c.c. The sample of water to be tested should be passed into the bottle through a glass or rubber tube extending to the bottom. Where the dissolved oxygen is to be determined from hot-water samples, the water should be cooled to about 70 deg. F. by passing through a copper cooling coil prior to discharging into the sample bottle. The water should pass through the bottle, slowly flowing for at least five minutes, and the quantity wasted should be not less than five times the capacity of the bottle. The sampling tube should be withdrawn from the bottle before the water is shut off and the glass stopper then replaced.

Remove the glass stopper from the bottle and add 1 c.c. of manganous sulphate solution and 3 c.c. of alkaline potassium iodide, using separate pipettes for each solution. These solutions should be discharged at the bottom of the bottle. After the addition of the chemicals the stopper is replaced and the bottle shaken and permitted to stand five minutes. A brown precipitate will settle. The stopper is again removed and 2 c.c. of hydrochloric acid are added, the stopper replaced and the bottle again shaken. By the addition of the acid the precipitate will be dissolved. (It is necessary that all precipitate dissolve.) The procedure up to this point should be carried out as quickly as possible, but the remaining portion of the test may be delayed for several hours if necessary without introducing an error in the determination.

Two hundred cubic centimeters of the treated sample are then transferred to a flask of 500 c.c. capacity and standard sodium thiosulphate solution (one-fortieth normal) is added from a burette drop by drop until the yellow color of the water has been nearly removed. When this point is reached ½ c.c. of the starch solution is added. The color of the sample will be changed from yellow to blue by the addition of the starch. The thiosulphate solution is again added to the sample drop by drop until the blue color is completely removed and the sample is colorless.

Read the burette and determine the number of cubic centimeters of thiosulphate solution used in the test. This amount will be the dissolved oxygen present in the water expressed in parts per million by weight. To convert the dissolved oxygen from parts per million to cubic centimeters per liter, multiply parts per million by 0.698.

Example: Number of cubic centimeters of thiosulphate used in test, 8.2 c.c.; dissolved oxygen in parts per million, 8.2; dissolved oxygen in cubic centimeters per liter = $8.2 \times 0.698 = 5.72$.

Test VI—Total Solids

The total solids of a water are the solid material remaining after the liquor has been completely evaporated.

The test is made in the following manner:

Place 100 c.c. of water in a weighed evaporating dish having a capacity of from 125 to 150 c.c. Evaporate slowly over steam or on a hot plate until all the water has disappeared and the dish is dry. Place the dish with its dried material in a dessicator for one hour and then weigh. The increase in weight expressed in milligrams and multiplied by 10 equals the total solids expressed in parts per million.

Example: Weight of evaporating dish, 84.9927 grams; weight of evaporating dish after evaporating 100 c.c. of water, 85.1064 grams. $85.1064 - 84.9927 = 0.1137$ gram, or 113.7 mg. $\times$ 10 = 1,137 parts per million.

Test VII—Suspended Solids

It is desirable frequently to have a record of the amount of suspended solids not only in the feed water, but in the blow-down water, which in turn is an indication of the accumulation of solids within the boiler.

Procedure: The difference between the total solids in the filtered and unfiltered samples of the water is the suspended solids:

Example: Total solids in an unfiltered sample of water, 2,060 P.P.M.; total solids in the sample after the suspended matter has been filtered out, 1,820; difference, or suspended solids, 240 P.P.M.

Test VIII—Total Hardness

The hardness of a water is a measure of the amount of calcium and magnesium dissolved in the supply. An approximation of these salts may be obtained by determining the soap-destroying value of the water. The test is extremely simple and is desirable for routine plant testing, especially for the control of softening systems.

Place 100 c.c. of the water to be tested in a glass-stoppered bottle (having a capacity of 200 to 300 c.c.). Add the standard soap solution a few drops at a time, shaking the sample after each addition. In the presence of calcium and magnesium and some other compounds, no lather will form until these salts have been destroyed. When a lather or suds remains on the surface of the liquid for five minutes or longer, it indicates that the scale-forming ingredients have been removed by the soap. Knowing the value of the soap solution, the approximate amount of these constituents may be calculated.

Example: Assume each cubic centimeter of the soap solution[1] has a value of 1.05 mg. of hardness calculated as calcium carbonate and that 12.4 c.c. of the solution were required to produce a permanent lather. Then the hardness of the water would be 1.05×12.4, or 13.0 mg. per 100 c.c. or 131 mg. per liter, equivalent to 131 parts per million.

Conductivity Tests

Pure water is a poor conductor of electricity. Conductance increases, however, when salts or acids are dissolved in the water supply. For this reason conductivity tests are of value in determining the characteristics of feed water. Appliances for this work are

[1] The strength of soap solution employed by the various water-softening companies and chemical supply houses differs greatly. The value of the solution should be determined and checked from time to time, since its strength changes with age.

now available and may be calibrated so as to determine the salt content, alkalinity or acidity or total concentration of solids in the water. Instruments of this kind may be indicating or recording.

Test IX—Sulphates

The determination of sulphates, especially in concentrated boiler water, is now considered of importance. Present knowledge on this subject indicates that under some conditions the proper conditioning of feed water depends upon maintaining a specified ratio between the carbonates and sulphates. The rapid determination of the sulphate content of water may be obtained by adding a solution of barium chloride to the water and estimating the sulphates by the amount of barium sulphate precipitated. One form of sulphate tester used extensively for this purpose consists of a glass jar, on the front of which is a graduated scale. Back of the jar is an electric bulb. The light from the lamp passes through a small prism, permitting a thin stream of light to pass through the jar. The test is made by placing a given quantity of water in the jar and adding 10 c.c. of a barium-chloride solution to the water. This chemical in the presence of sulphates forms a white precipitate. If the sulphates are sufficiently concentrated, the beam of light is not discernible. The sample is then diluted with distilled water until the beam of light is just perceptible. When this point is reached, the amount of sulphates may be determined, reading the height of water reached on the scale etched on the front of the glass jar. The tester is convenient and sufficiently accurate for plant control.

Elyria Iron & Steel Company Has Well-Laid-Out Steam Plant

WHILE there is nothing revolutionary about the recently constructed boiler plant of the Elyria Iron & Steel Co., in Cleveland, it is a fine example of an up-to-date boiler house, well laid out, wonderfully lighted and neat as a pin. These qualities, often preached, are still the exception rather than the rule. Housed in a building that is mostly windows on all four sides, are two 2,500-sq.ft. Stirling-type boilers equipped with underfeed stokers. These are engine driven, as no current is generated in the plant, which makes steam for heating and process work. Steam generated at 125 lb. is reduced to 50 lb. and subsequently to 2 lb. for heating.

Coal is carried by a boot-type bucket elevator to two tank-type overhead bunkers, from which it is fed by chutes to the stoker hoppers. The boiler house is also equipped with simplex feed pumps, open heater and vacuum pumps for the heating system.

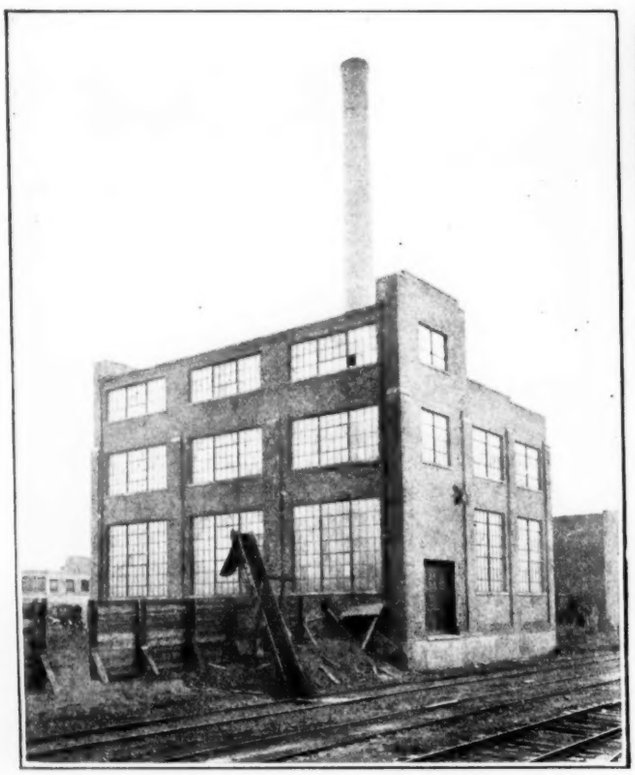


Fig. 1—The boiler house is mostly windows

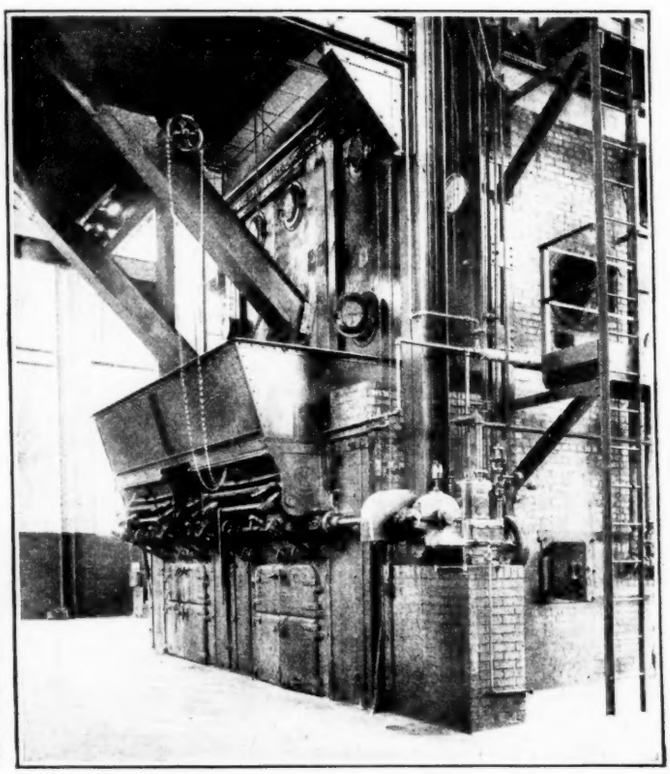


Fig. 2—Few large plants are as shipshape

Avoid Hasty Comparisons

ADDRESSING the delegation of German Power Engineers, which is now on a tour inspecting plants in this country, John W. Lieb very appropriately cautioned against the making of hasty comparisons between practice here and in Germany, pointing out that a thorough appreciation of local conditions should precede any such comparisons.

This bit of wisdom is applicable not only to foreign engineers, inspecting plants in this country, and American engineers visiting abroad, but also holds as between our own plants.

One power station, situated where coal is expensive, may incorporate most of the refinements known to present practice, whereas a second of like capacity and service, but favored with cheap fuel, may be found operating with few refinements, yet showing a greater financial return in spite of a lower thermal efficiency. Again, a station operating under conditions where continuity of service is vital, may be justified in sacrificing some economy and at the same time incurring a high initial unit cost as compared with another backed up by the reserve of a power system or supplying a load where an occasional interruption would not be serious.

Similarly, in the industrial field the casual observer may sometimes be perplexed at noting one manufacturer generating his own power, whereas his neighbor, turning out a like product under apparently similar conditions, is purchasing all or part of his electrical energy. Yet in none of these cases may there have been poor engineering or poor economics employed. Thermal efficiencies, size of units, initial costs and the generation or purchase of power, in themselves mean little unless accompanied by a knowledge of the local conditions that pertain.

Mr. Lieb's advice to our foreign visitors is worth keeping constantly in mind when visiting or discussing power installations.

No Five-Day Week for Engineers

HENRY FORD several years ago upset industry by his five-dollar minimum wage. Despite predictions to the contrary prosperity continued unabated and a general wage increase followed in most lines of labor. Of late Ford has again startled the world by the innovation of a five-day week. Organizations that are still celebrating the winning of the steel mills to the eight-hour day hail the decision of the automobile magnate as a gesture that may be likened to a direction sign pointing the way industry as a whole must eventually go.

As a whole, those engaged in power-plant engineering cannot be expected to show much interest in the short-week movement. Long hours per day and many days per week are living arguments to them that a five-day week can only be a chimera.

Engineers enjoy leisure as well as do any, and while some waste the time in useless pursuits, the more progressive employ non-working hours in enlarging their store of knowledge. But engineers face the bare fact that without exception no trade, craft or profession works as many hours per year. With the exception of the larger plants where there are three shifts, long hours is such a custom in the power plant that it is accepted as being unavoidable.

Even in plants where the factory hands work nine hours daily, the engineers are expected to start an hour earlier and linger an hour after the five o'clock whistle blows. In the main, even on Saturday afternoons, the power-plant force is expected to be on hand, and Sunday work without overtime pay is a customary condition.

In a one-man power plant this continual grind may be necessary, but in any power house employing an engineer and a helper, the shifts can be arranged so that long hours will be avoided. Sunday and holiday jobs are generally escapable if due care is exercised during the week days, so that repairs are not necessary.

Engineers cannot expect to gain more leisure hours unless they give some thought to a better scheduling of the routine work and the rearrangement of the shifts. That many work seventy-two to eighty hours a week is the fault of these particular engineers.

Curiosity Pays Dividends

IN SPITE of its frequent abuse, curiosity has probably done more to advance civilization than any other single attribute of the human mind. This is particularly true of its highest expression—scientific curiosity. If certain men in each generation had not been driven by this irrisistible urge to find out what happens and why, science and engineering simply would not exist in a form even faintly resembling their present state.

Science advances in a series of steps. While some of these steps have been taken for practical reasons, such as the desire to make money, most of them were taken simply because the desire to find out was too strong to be resisted. Any number of examples might be drawn from the history of science to prove that this is the case, but a few will suffice to illustrate the point.

The classic example is Faraday, that prince of experimental workers. His discovery of electro-magnetic induction, out of which sprang the electrical generator, the transformer, the telephone and countless electrical appliances, was made solely because he was inquisitive. Faraday was not looking for fame or money; he had no practical end in view. Yet the results of his labors must now be valued in thousands of millions of dollars.

Herz was not practical — merely curious — yet his discovery is the keystone of the great radio industry. Again, the Welsbach mantle was a byproduct of what must have seemed at first the most useless sort of

research—an investigation of the properties of the rare-earth metals. Some of these same "useless" metals are now essential to the manufacturer of such important products as alloy steels and tungsten lamps.

A recent and sensational example of the practical value of curiosity is the atomic-hydrogen welding torch. Doctor Langmuir started out to find out what goes on inside the bulb of a tungsten lamp. The lamp and its process of manufacture had already been perfected. No practical end was in view, least of all any contribution to the art of welding. But scientific curiosity found the practical where none was sought. Extraordinary things were taking place within the innocent looking bulb, things no one could have guessed in a thousand years. One trail led to another, the final result being the discovery that hydrogen molecules could be broken up into atoms by the electric arc, later to recombine in an intensely hot flame free from oxygen. At that point the engineers stepped in and developed the torch which constitutes an outstanding contribution to the art of welding. It is as though one started on a star-gazing expedition and ended up by finding a pot of gold buried under a tree.

The lesson is plain: industry can well afford to subsidize scientific curiosity, particularly when it goes hand-in-hand with ability.

Accurate Information on Service Requirements Needed

RATING of electric motors is apparently one of those engineering questions that will not stay answered, as it frequently comes to the front in a new form. For a long time the forty-degree rating with a twenty-five per cent overload for two hours was the standard. This was followed by the fifty-degree motor, and later the forty-degree rating without any overload became the standard. In the latter there has recently been included a service factor, which, when authorized by the manufacturer, allows increasing the rating of open-type general-purpose motors fifteen per cent for certain classes of service, when operated at standard frequency and voltage.

There are a number of practical and economical reasons for the adoption of this service factor, in the wide variation of conditions under which motors operate. However, the problem remains, how to apply this factor generally. The average purchaser is more interested in getting a motor that he can be sure will do the work, than he is in any close loading of the machine. Until those who sell the motors are willing to take the responsibility of the machine's doing the work for which it is sold, the purchaser is going to "play safe," just as he has in the past. The fact that probably eighty-five per cent of the motors in service operate regularly at less than sixty per cent of their rating indicates how safely the purchaser has been going when applying motors.

In most cases the buyer is not at fault in this problem of overmotoring. Those who sell the motors and should be in a position to give definite information on the size required, are frequently not much better off than the purchaser with respect to these requirements. Frequently, the seller is willing that the buyer shall take a motor that is probably oversized for the job, so as to be sure that it will do the work. An oversized motor does the work and keeps the customer satisfied, whereas, if a mistake is made and the motor is too small, the purchaser is dissatisfied. More accurate information on the capacity of motors required for given applications will do more than probably any other one thing to insure better loading. Whenever motors are purchased on more or less of a guess, the most natural thing to do is to try and guess on the safe side.

Accurate information is not always easy to obtain, on account of the wide variation of conditions. The kind of product made by the machine may vary through wide ranges in power requirements. If, when making one kind of product in a machine, twenty horsepower is required, and when making another five horsepower will do the work, it is evident that a fifteen per cent service factor is not going to contribute very much toward keeping the motor loaded. It must be large enough to take care of the maximum load safely no matter what may be the light loads.

A fifteen per cent service factor, if intelligently applied, will no doubt help to attain a better loading. But if this had been applied to the large percentage of motors that are operating at little over fifty per cent full load, these machines would still be working far below rated capacity. Evidently, something more than a service factor is required before the difficulties of overmotoring are eliminated, and this is better information on the service to which the motor is applied.

A process sometimes mistaken for constructive thinking is that of self-justification, or "rationalization," as the psychologists term it. While engineers have been known to indulge in this kind of indoor sport, they should be thankful that the practice of engineering tends to cure the habit. Engineers deal with such concrete things as money, weights, pressures, powers and temperatures. These can be measured, and measurements have a way of backing up the man who fits his thinking to the facts.

In most industries the cost of power is a relatively small part of the manufacturing cost of the finished product. For this reason it does not always receive due attention. Nevertheless, when viewed as equivalent at least to dividends paid, it assumes proper significance. That is, if management can be sold on the idea that a twenty-five per cent saving in its power cost through modernization of its plant means a twenty-five per cent increase in dividends, the reaction is likely to be most favorable.

The final article of the feed-water series by Sheppard T. Powell appears in the present issue. This series was referred to at the start as the most complete and modern treatment of the subject so far attempted and appears to have justified the description. As requests for clippings and reprints are being received, attention is called to the fact that these articles, somewhat expanded in detail, will soon appear in book form. The need for such a book is evident.

Knowledge of the fact that Switzerland has already developed seventy per cent of her available water power, serves ninety-seven per cent of her population with electricity, and has a total per capita consumption of six hundred and twenty kilowatts annually, may surprise some American engineers who are prone to boast of our progress in power development and utilization.

Practical Ideas From Practical Men

Prolonging the Life of Furnace and Ashpit Doors

In some cases the furnace doors are found in good order, although they have been in service for several years, while in others they are in bad condition. The linings are burned out, the latches are broken off, and the doors are sprung out of shape so that they cannot be closed tight. Ashpit doors seem to fare better. In some cases they have been removed entirely in order to prevent improper use of them.

It is not intended to convey the idea that either of the doors mentioned should be expected to last indefinitely even with the best of care, but rather to point out some mistakes made by firemen while using them and to give some suggestions which, if put into practice, will prolong their usefulness.

I have seen firemen shovel soft coal into a furnace until the pile reached the arch plate and covered the dead plate. After some had run out of the furnace and formed a little pile on the floor, the door was swung against the pile and difficulty was had in closing it tightly. Where such a practice is tolerated, the furnace doors must soon be burned out because it prevents a free circulation of air, and also because it brings the fuel too near the linings of the doors. The fuel should never be allowed to stay on the dead plate long enough to ignite.

Some furnace doors are not perforated sufficiently to keep them cool. In such cases holes should be put in them at the first opportunity, and it might be added that there is a vast difference between making an opportunity to do such work and waiting for one to "turn up." Many furnace doors have ventilating grids cast in them, which may be closed at will by means of a circular cover. I sometimes think that it is best to omit these covers, for then they cannot be closed accidentally when they should be open. Perhaps there is never a time when they should be closed completely.

Boilers that are fitted with half-arch or overhanging fronts should have well ventilated furnace doors, as the fire is always near the linings, and these linings should have many small holes in them, but a less number of holes of a larger size in the door itself is a good plan. A majority of ashpit doors are cast solid, and when even a small quantity of air is wanted, they may be opened slightly. This is proper, for with few exceptions, these doors should be thrown wide open when a fire is started and kept so long as a fire is burning on the grate. The draft should be regulated by a damper in the chimney or stack.

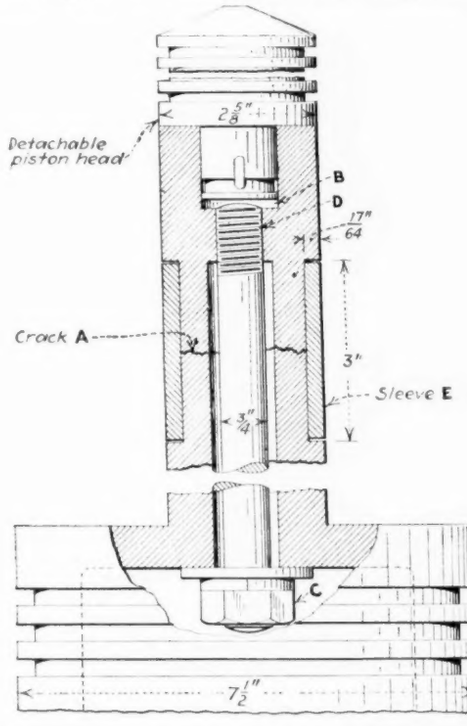
I remember one case where a boiler was driven so hard that furnace doors would last but a few months. In my own plant some of the furnace doors have been in service for more than twenty-five years, and all the original linings are still in good order.

When it is time to bank the fires, the ashpit doors are closed tightly. If closed at any other time, it prevents the circulation of air through the grates, and as a natural result the bars may be overheated and warped. Where this happens, the engineer may order the doors removed, but this plan is not recommended, as it may make it necessary for the fireman to open the furnace doors when he wishes to prevent a further rise in pressure, and that should not be tolerated.

New Haven, Conn. W. H. WAKEMAN.

A High-Pressure Air-Compressor Piston Repair

About two years ago a crack developed in the high-pressure piston of the air compressor used with a 200-hp. Diesel engine. The top portion was still held by a small piece of metal when the compressor was dismantled for repairs. The illustration shows how the repair was made.



Partial section of high-pressure piston showing sleeve and drawing-up bolt in place

First, the piston head was removed and a hole *D* was drilled and tapped for ¾-in. standard thread. Then a piece of round mild steel was threaded at both ends and screwed in and the top and bottom portions drawn together as indicated. Then the piston was chucked in the lathe and a recess 17/64 in. by 3 in. long turned over the crack as shown.

Before loosening the nut *C* and breaking the piston at the crack, a line was drawn longitudinally with a surface gage, so that the two halves could be drawn up

properly in line. A sleeve *E* turned out of a bar of cold-rolled steel, having an inside diameter 0.002 in. less than the piston at the bottom of the recess was then put on, by heating it and inserting the halves of the piston. The washers and nut were immediately replaced and tightened up and the piston allowed to cool. The compressor has operated approximately 8,000 hours since the repair was made. JAMES M. BLOOMFIELD.

Kamsack, Sask., Canada.

Points on Operating Double-Eccentric Corliss Engines

When starting up double-eccentric Corliss engines, it is necessary not only to support the governor so release of the steam valve will occur inside the range of cutoff, but to see that the dashpot closes the steam valves the instant release takes place. This is true not only in starting up, but also in regular operation, especially in case of overload.

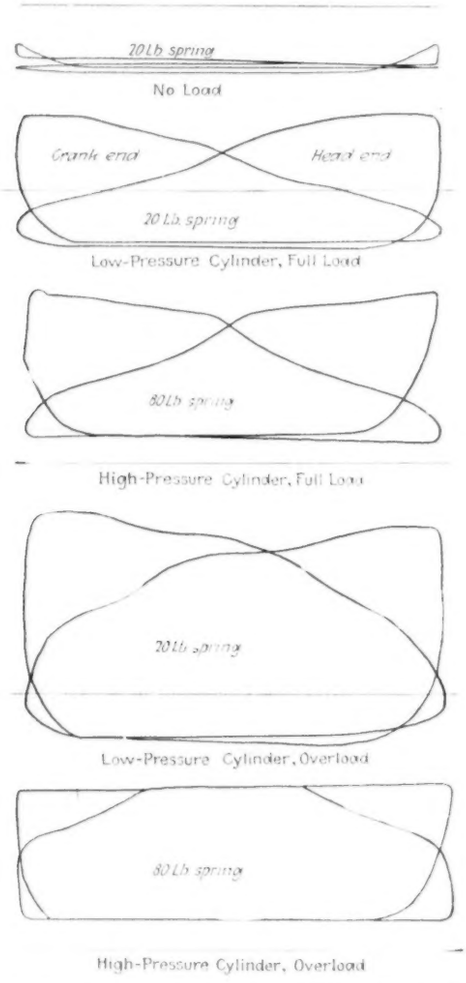


Fig. 1—Diagrams from a compound rolling-mill engine at no load, full load and overload

The accompanying diagrams were taken from a 52 and 84x60-in. rolling-mill engine. The overload diagrams show what an engine is sometimes called upon to do. If the low-pressure steam inlet valves fail to close before the exhaust valves open, the engine, especially when carrying an overload, will practically stop, and in the case of a rolling mill the mill will be full of steel and will have to be cleaned before operations can be resumed.

On one occasion we remedied the trouble from steam valves failing to close by making new valve cranks and attaching the dashpot links at a greater radius, as shown at *C*, Fig. 2. The construction of the dashpots was such that this was possible without changing them.

I recall one instance in the East in connection with the installation of a 48 and 90x60-in. engine direct-connected to a generator for street-railway service in which the engine erector insisted on all steam valves being hooked up when we went to start up for the first time. There was considerable time and steam wasted in the attempt to start the engine with all the valves open, but we finally got it started by dropping the steam valve on the end where the exhaust valve was open, while the erector was out of the engine room.

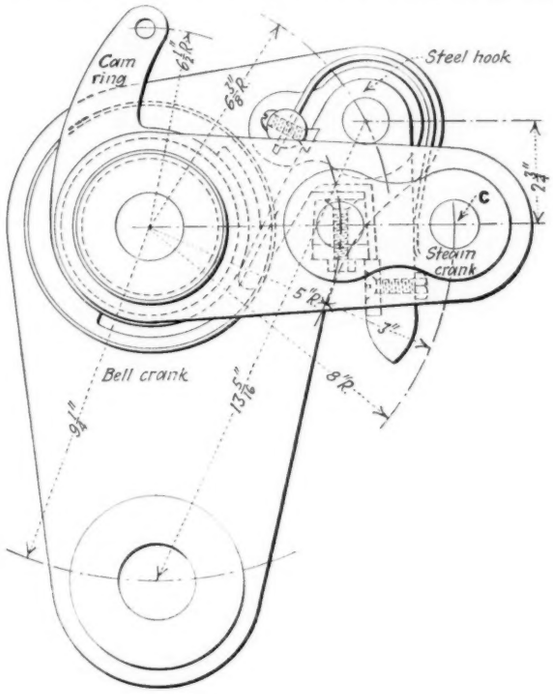


Fig. 2—Valve crank with dashpot link attached at long radius

Our experience in this vicinity has been with engines of many different makes with cylinder sizes running up to 110 in. diameter, 84 and 90 in. diameter being quite common with strokes of 48, 60 and 72 inches.

Youngstown, Ohio. D. P. TOLTON.

Examine Your Soot Blowers

Some time ago an engineer called me into his boiler room and showed me where the steam soot blower had cut a hole nearly through the mud drum of an inclined water-tube boiler. The steam from the blower, which must have been left on a longer time than was necessary, together with the soot and small particles of ash, had caused a sand blast action on the plate. The blower element was located within 3 in. of the drum when it should have been at least 18 in. away from the drum.

I would suggest that each engineer who reads this give his soot blowers the once-over and see if they are doing any damage. DOUGLAS E. BISHOP.

Detroit, Mich.

Comments from Readers

Welded Pressure Vessels

In the issue of Sept. 28 there is an article by A. F. Jensen, president of the Hanna Engineering Works, Chicago, on the subject "Are Welded Pressure Vessels Safe?"

In this are brought up numerous cases of failures and some reports of various organizations which have proved that welded pressure vessels are not safe. I don't believe that the matter of safety at the present time really has much bearing on the subject, and I doubt if the people who are questioning the safety of electric welding are fully advised as to the extent to which welding is used. For instance, I think it is safe to say that Mr. Jensen in his last trip on a railroad, depended one hundred per cent on arc welding for his safe arrival at his destination, and if electric welding had failed on the engine that carried his train, he never would have arrived at his destination, because I think it is safe to say there is not a single locomotive in the United States that hasn't at least its tubes welded in, and I believe that probably 20 per cent of them have their frames arc welded.

Another remarkable thing in the questioning of the safety of arc welding, is the fact that all superheaters must be arc welded on account of the very high temperatures at which they operate—they can't be riveted and have them hold, so we are in the rather anomalous position of having the steam generated in the boiler at a certain pressure and then passing through a superheater at the same pressure but at a very much higher temperature before it is used in the cylinder. In other words, if steam is generated at a certain pressure and at a certain temperature that is low, riveting must be used, but if we increase the temperature of the steam, arc welding must be used. It is rather hard for the man in the street to understand why, if the superheater can be welded safely, the boiler that generates the steam that passes through the superheater cannot also be welded.

Mr. Jensen speaks of the fact that there have been a number of cases of failures of weld, although he is careful to state that the weld showed very definitely that it had not been properly made. There are any number of machines on the market at the present time that entirely remove the personal element and do all this welding automatically, and it would seem to me that up-to-date apparatus of this kind could and should be used in places where reliability of the weld is an important matter.

I doubt if the well-known rivet can be put in properly unless heated to somewhere near the right temperature and hammered into place with somewhere near the proper technique. If it is done by a bull riveter, you are fairly sure that you are going to get a good job; if it is done by men who have never heated or never driven a rivet before, I should say the chances for a successful job would be, to some extent at least, interfered with.

There has never been any question with any of the people who are at all in touch with the situation as to whether a welded vessel is safe or not; they all know it is safe. The only question that comes in is whether the welding which is done is safe or not, or in other words, whether the welding has been properly done. Why not do it in such a way that there will be no doubt about this point? That would seem to me the obvious procedure.

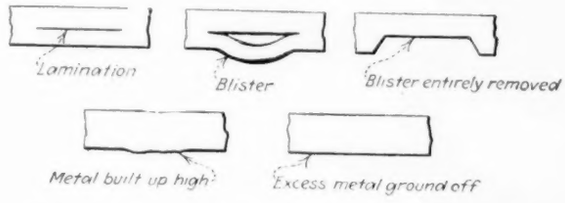
J. F. LINCOLN, Vice-President,
Cleveland, Ohio The Lincoln Electric Co.

Repairing Bags and Blisters in Boilers

In an article in the July 6 issue on "Stunts With the Welding Torch," the statement is made that "small blisters" (presumably in boiler tubes) "are heated and hammered up, and that such repairs never give any trouble or come down again."

Hammering up cannot be applied to any tubes other than those in water-tube boilers, and no matter where a blister may be, I do not see how it can stay put.

A blister is the result of a lamination in the plate usually caused by slag. The side of the plate to which



Blister is removed and plate built up by welding

the heat is applied becomes overheated and bulges outward, while the other side of the plate retains its shape. Now merely to hammer up the bulge would not remove the fault in the metal, and when heat is again applied blistering would recur.

In my opinion the proper way to repair a blister is to cut away the bulged metal entirely, making sure that none of the lamination remains. The plate should then be built up to its original thickness by the deposition of metal, preferably by the electric welder or, if a smooth job is desired, to a little over its original thickness, and the excess metal ground off. The sketches will illustrate my meaning.

In the Aug. 3 issue we are advised that before driving up a bag we should drill a small hole in the center of it. I have never seen this done, although I have heard of it, but I have seen bags driven up without the hole, which would indicate that the hole is not necessary.

Another point to be observed is that if the plate is driven back to its original curvature when it is hot, it will be hollow, or low, when it cools. When getting the bag back to near the original curvature, it is well to let the plate cool off and note the curvature when it is cold.

Toronto, Ont., Canada. R. MCLAREN.

Engineers' Wages

In his letter in the July 27 issue on the subject of engineers' wages, Thomas M. Street states his belief in the old adage, "Those who do no more than they are paid for, never get paid for any more than they do." Few people will differ with him on this point, although the word "never" will meet with some skepticism. But the point at issue is whether the reciprocal of the adage is true, to wit: "Those who do more than they are paid for, always get paid in the end for what they do." This may be true—it is even probably true—but payment is certainly not made in cash in the case of our stationary engineers.

The question of the relative value of workers and the salaries they should be paid, is an intricate one, and one that we may never be able to solve, for lack of a common unit of measurement. Is a bricklayer worth three or four times as much as an engineer? In certain emergencies is not an efficient tower man with presence of mind worth much more than a dozen railroad presidents?

These are difficult questions to answer. Yet one point is surely beyond discussion: Any man, whether ditch digger, engineer, college professor or bank president, who is honest and faithful in his endeavor to do his duty in his particular sphere, and who is at least approximately successful in accomplishing the task set before him, deserves to be able to rear a family in health and comfort and to give his children an education and enough recreation to counteract the wear and tear of a life of labor.

Now I do not know what Carl F. Miller was getting, after fourteen years on the job. But the bid of the United States Civil Service Commission quoted in the "Foreword" of the March 23 issue, calling "for a first-class steam-electric engineman . . . to have charge of the operation, maintenance and repair of a large heating, lighting, and power plant, and all auxiliary mechanical and electrical devices and equipment," for which a salary of $1,500 was offered, holds scant promise of such a life. And if the chief of this plant is to get $125 a month, what will his helpers get, and how will they live?

In the final analysis most of the responsibility for this situation lies with the engineers themselves, harsh as this may sound. In these times of political and economic strife, the motto of the National Association of Stationary Engineers, that "This Association shall at no time be used for the furtherance of strikes, or in any way interfering between employer and employee," is worthy of unstinted admiration and praise. It would be deplorable if such a spirit should be trampled under foot in the struggle between individuals and classes for greater liberty or privilege.

There is only one way out of this situation—the engineers must be strong enough to command better wages. Theirs is one of the highest of all trades, for it calls for knowledge, practical experience, moral courage and a high sense of responsibility. It offers a broad field for progress through personal ingenuity and initiative. The engineer not only has almost absolute control over one of the important factors—often the principal one—in production costs, but the security of human lives, often in large numbers, and of valuable equipment and property depends on his efficiency and unselfish service.

Such service deserves an adequate wage—I do not say reward, for this would imply a certain surplus or bonus—and the engineers are sufficiently powerful to insist upon it. Can they do this without sacrificing the noble and high-minded principles of their association? I believe so. Cannot the association first make a careful study of present-day living and working conditions, and fix what would be considered a fair schedule of wages, based partly on the size of the plant and partly on the practical experience and years of service of the man? Let it send this schedule out to all its members and also to the chiefs of all important power-using industries, with the recommendation that it be given favorable consideration. Let it finally call a conference with far-sighted leaders in industry, to enlist their co-operation in this just cause.

There is every chance that these peaceful means would bring satisfaction to all parties and be an example to many other trades. If they failed to do so, then a militant organization should be formed to fight for the rights of the men. Something should be done, and done now.

R. H. ANDREWS.

Paris, France.

Comparative Economy of Non-Condensing Uniflow and Steam Turbine

In an article on page 396 of *Power*, Sept. 14, reference was made to the vertical 6-cylinder uniflow installed at the University of Missouri power plant. The engine is at present operating non-condensing, as it was thought that the electric load was not large enough to justify the expense and added complications of condensing operation. However, it is designed with clearance pockets, which can be closed in case it is desired to install a condenser in the future.

Exhaust steam from the plant is used for heating a number of buildings nearest to it. Steam economy in the heating season, therefore, is not a major consideration, but in the non-heating season, when exhaust steam goes to the atmosphere, steam economy is essential if the cost of electric generation is to be kept within reasonable bounds. Alongside of the uniflow is a non-condensing steam turbine driving a 200-kw. generator, which was operated continuously for several years past, with satisfaction in the heating season, but with so high a steam consumption as to make it quite unsuitable for summer operation.

In order to get a line on the relative performance of the two units, a comparison was made of the coal burned in August, 1925, when the turbine was operated, and August, 1926, when the engine carried the load. The same kind of coal, furnished by the same company, was used in both months. The service, consisting of electricity, water supply, steam for laundry, hot water supply, etc., was about the same. Any difference in coal burned is due mainly to the difference in steam economy of the two prime movers. The records were as follows:

Coal burned, July 30 to Aug. 30, 1925	1,095,878 lb.
Coal burned July 30 to Aug. 30, 1926	825,995 lb.
Saving due to uniflow engine	269,883 lb.

Estimated saving in five months non-heating season, 674.5 tons, which with coal at $3.60 per ton, brings the yearly saving to $2,428.20.

At this rate the saving should equal the difference in cost between this engine and a non-condensing turbo-generator of the same capacity in less than four years.

A. L. WESTCOTT, Supt. of Bldgs.,
Columbia, Mo. University of Missouri

Cost of Coal and Power Comparatively Small Item in Manufacturing Industry

I noticed a statement in the "Foreword" in the July 27 issue as follows: "The total coal bill of the country for the last year was over $2,700,000,000, or nearly 25 dollars per unit of the population."

I am wondering if this statement will not convey to the average reader the impression that this sum represents the amount that went into the pockets of the operators. From figures that we have at hand, the "value" of the coal at the mine, both anthracite and bituminous, sold in 1925, was $1,400,000,000. Of course, this represented a shortage of about 28,000,000 tons of anthracite due to the anthracite suspension. I think it would be helpful to add a few more facts:

Realizing that the railroads paid in excess of five hundred million dollars for the supply of bituminous coal, which represented 84 per cent of their total expenditures for fuel, it is well to consider for a moment just how great or how small a burden this was to them. Their expenditures for all kinds of fuel represented but 12.5 per cent of the total operating expense of the railroads and 9.7 per cent of the total operating revenue. The purchase of bituminous coal represented 10.5 per cent of the total operating expense and 8.2 per cent of the total operating revenue. Thus if the bituminous coal required by the railroads of the United States in transporting the commerce of the land had been furnished free during the year 1923, the total operating expense would have been reduced by only 10.5 per cent. It seems to me it then becomes apparent that the bituminous-coal industry has not been a burden to the railroads. To be entirely fair, I should say that there is a slight inaccuracy in the percentages I have just quoted, for the figures for railroad fuel cost do not in all cases take into account the transportation and handling charges of railroads moving their own coal.

Going a little further in our study of the railroad figures, we find that while the bituminous coal purchased by the railroads in 1923 cost for the coal at the mine and transportation charges the sum of $519,007,000, the transportation of bituminous coal furnished the railroads with revenue amounting to $856,242,000. Thus the railroads in revenue on bituminous coal moved, received $337,235,000 more than they paid for all bituminous coal purchased by them. The revenue from the transportation of bituminous coal represented 18.5 per cent of the total freight revenue of the railroads and more than double the amount of any other single commodity.

The products of agriculture, concerning which there has been quite a movement for a reduction in rates, furnished 14.5 per cent of the revenue, or $672,433,000. Forest products furnished over $400,000,000 of revenue, while general manufactured and miscellaneous products brought in a total of $1,319,100,000. To add all coal, both bituminous and anthracite, and coke, we find that therefrom came one-fourth of the freight revenue of 1923.

Let us turn to the Bureau of the Census and see just what relationship the purchase of fuel and power bears in various lines of industry. It represents the highest percentage in the iron and steel blast furnaces, for there 29.7 per cent of the value of the finished product is represented by the cost of fuel and power. That percentage is less than 1 per cent in the automobile industry, including bodies and parts. In bread and other bakery products it is 1.7 per cent; in cotton goods it is 1.7 per cent; in electrical machinery, appliances and supplies it is 1.4 per cent; foundry and machine shop products show 1.6 per cent; iron and steel, steel works and rolling mills, 5.5 per cent; leather, tanned, curried and finished, 1.1 per cent; paper and wood pulp, 7 per cent; rubber tires, tubes and rubber goods, 1.3 per cent; smelting and refining of copper, 3 per cent; sugar refining, not including beet sugar, 1.3 per cent; woolens and worsteds, 1.2 per cent; and taking the average for all manufacturing industries we find that while the value of the finished product was $62,418,079,000, the total cost of fuel and power was $1,645,987,000, or 2.6 per cent, including the cost of the transportation of the fuel.

Thus it is seen that if the total cost of fuel and of power be eliminated in all manufacturing industry, the only reduction that would make would be an average of 2.6 per cent. Certainly, the coal industry is not a great burden on manufacturing generally when, including the transportation and all other kinds of fuel and of power, the total cost to that industry is only 2.6 per cent of the value of the finished products. The figures given are from the Manufacturers' Census of 1919.

HARRY L. GANDY, Executive Secretary,
Washington, D. C. National Coal Association.

Proposed Piping Specifications

In *Power* for Aug. 24, 1926, the proposed tentative specification for lap-welded and seamless steel pipe for high-temperature service was reproduced (with credit) from the Station Piping Report of the N.E.L.A. Prime Movers Committee. This specification was originally prepared by an A.S.T.M. committee, of which Dr. A. E. White is chairman and the writer secretary. Doctor White serves as the Prime Movers Committee representative on the A.S.T.M. Committee.

In your reproduction of the specification I notice the omission of an important point which is one of the main reasons this specification is superior to any heretofore published. The part of the specification to which I refer is section 14 B, which reads: "The minimum wall thickness at any point for welded and seamless pipe shall be not more than 12½ per cent under the nominal wall thickness specified." This clause was written in the specification to cover a point on which there has been considerable difficulty in actual practice.

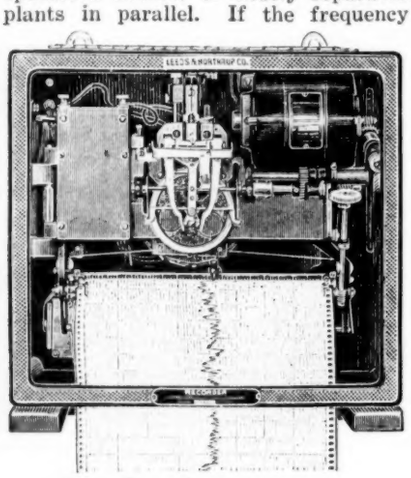
We hope that the dimensional table for pipe thicknesses for the different pressure ratings as published in this specification and reproduced in your article, will be adopted nationally in place of the extra strong and double extra strong grades of pipe at present in use. The thickness of extra strong and double extra strong pipe bears no definite relation to any uniform working pressure; that is, extra strong pipe in some sizes might give a factor of safety of five for a certain working pressure, while in other sizes it might give a factor of safety of seven or eight for the same working pressure. The new table of dimensions for 250-, 400-, 600-, 900- and 1,350-lb. pipe has a uniform factor of safety throughout, being based on the modified Barlow formula used in the A.S.M.E. Boiler Construction Code. This formula takes into account the weakening of pipe by threading and increases the thickness by a certain amount to compensate for this. The table just referred to also gives thicknesses which have been increased 12½ per cent to cover the under thickness wall tolerance.

Detroit, Mich. SABIN CROCKER.

New and Improved Equipment

Frequency Meter Records Fractional Part of Cycle

Interconnecting power plants and systems have made close frequency control of paramount importance. Meters that were satisfactory for operation of individual units, or of two or more units in parallel in the same plant, have proved unsuited to operation of large interconnected systems. One of the objections to these meters was that they could not be read close enough to operate a number of widely separated plants in parallel. If the frequency



Recording frequency meter

is not closely maintained in the different plants, there will be an undesirable shifting of load between stations.

To provide a means of giving a close record of the frequency on large systems, the Leeds & Northrup Co. has placed on the market a new type of frequency recorder, shown in the figure. This recorder uses the company's standard recording mechanism which has been used for all kinds of recording purposes during the last fifteen years. The electrical part of the recorder is an impedance bridge and alternating-current galvanometer. Two arms of the bridge consist of non-inductive resistance. One of the other two arms is a non-inductive resistance in series with a mica condenser, and the fourth arm is a non-inductive resistance in parallel with a mica condenser. The balance point of such a bridge is sensitive and makes possible obtaining a close record of slight variation in frequency. As the electrical circuits are constructed, the meter has practically a negligible temperature coefficient and variations in voltage also do not affect the accuracy of the galvanometer.

The power for operating the recording mechanism is a 110-volt synchronous motor. Since the chart is driven by a synchronous motor, the charts of all recorders connected to the same system will be driven at the same speed even though there are variations in the system frequency. This permits a comparison of the records obtained from different points of the system.

The charts are ten inches wide and the standard 25-cycle chart has a range of 24 to 26 cycles, and for a 60-cycle circuit the standard chart has a range of from 58 to 62 cycles. On the 25-cycle chart there are 100 divisions, so that each division, which is approximately 0.1 in. wide, represents 0.02 of a cycle. The 60-cycle charts have eighty divisions, and each division of approximately $\frac{1}{4}$ in. represents 0.05 of a cycle. Therefore, the 25-cycle recorder can be easily read to 0.02 of a cycle and the 60-cycle to 0.05 of a cycle.

Campbell Feed-Water Regulator

A type of feed-water regulator in which the movement of the feed valve is controlled by the pressure drop between two orifices through which a constant flow of steam or water is maintained from the water column, has been

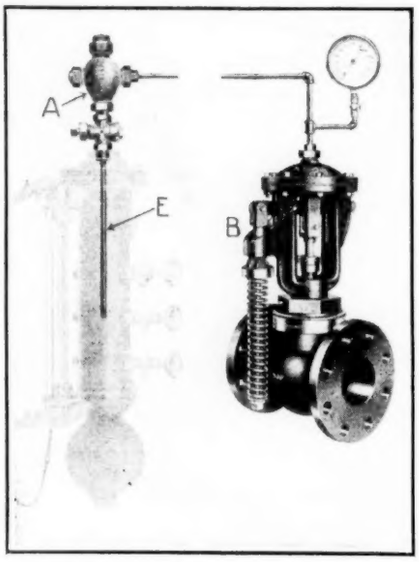


Fig. 1—Connections of regulating element and control valve

brought out by the Atlas Valve Co., 287 South St., Newark, N. J.

A regulating element *A* fitted with inlet and discharge orifices *C* and *D* (Fig. 2), is connected with the water column by a pipe *E* passing down through the top flange or connecting tee and ending at the normal water level. It is also connected through suitable piping with the pressure chamber of a control valve *B*, which regulates the amount of water fed to the boiler. The discharge port *D* of the element is connected to a receiving tank, heater or exhaust main as desired. As the inlet orifice *C* is very small, the flow through the element is negligible.

Referring to Fig. 1, it will be apparent that if the water in the column is below the end of the pipe *E*, only steam will flow through the element *A*. With steam only passing, owing to the relative sizes of the orifices, the pressure is reduced to a point below that required to operate the valve *B*, consequently the valve remains open and water continues to be fed into the boiler. But if the water level rises sufficiently to submerge the end of the pipe *E*,

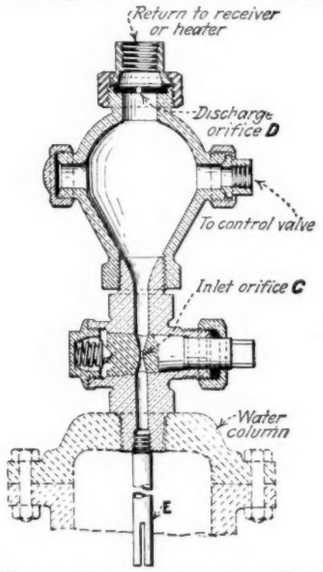


Fig. 2—Cross-section of regulating element

water passes to the regulating element. The heat contained in this entering water is more than the steam, owing to greater weight passing through the orifice *C*. Hence, as some of the water flashes into steam, it builds up a pressure sufficient to close the valve *B*. The pressure exerted on the control valve will vary with the percentage of water in the mixture passing through the element, and the amount of water admitted to the boiler will vary accordingly. The slot in the end of the pipe *E* tends to minimize the effects of any surging in the water column.

The control valve, which is closed by the pressure on the top of the diaphragm acting against the spring, is designed to operate well within the range of pressure produced by the regulating element.

In addition to the arrangement shown in Fig. 1, the pressure from the regulating element can be utilized to operate the throttle valve of the feed pump or the control mechanism of a motor driving a centrifugal feed pump as best suits installation requirements. Also, the pressure pipe can be of any length and be made to transfer the changes between the element and control valve regardless of their relative location.

How Much Excess Air?*

Notes on the Interpretation of Flue-Gas Analysis by E. G. Bailey †

THE most important single factor that may be used to specify combustion conditions is excess air, but unfortunately the majority of people today refer to combustion conditions by stating the percentage of CO_2 rather than the percentage of excess air. This has a distinct disadvantage as the relation between excess air and CO_2 varies widely with different fuels. As shown in Fig. 1, the CO_2 will range from 7.5 per cent with coke-oven gas to 22.8 per cent with blast-furnace gas, for 20 per cent excess air. Even with coal the CO_2 varies more than one per cent for the same excess air. It is becoming more common to change from one kind of fuel to another such as coal, oil and gas, and often to burn both gas and pulverized coal or other fuels in the same furnace simultaneously. It is therefore quite important to analyze the flue gas for more than CO_2 to determine the percentage of excess air. Fig. 2 shows that the percentage of oxygen is a much closer indication of excess air than is the percentage of CO_2, but even oxygen varies with different fuels, depending upon the hydrogen-carbon ratio, so that it alone is not a true indication of excess air.

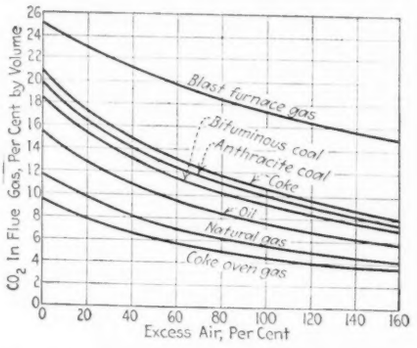


Fig. 1—CO_2 is not a measure of excess air for different fuels

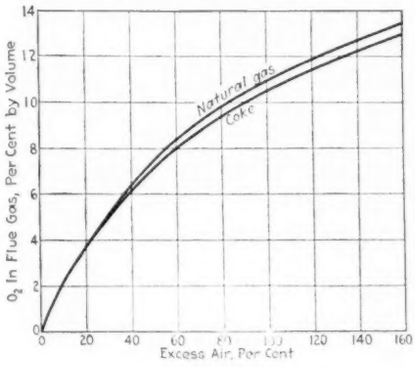


Fig. 2—Oxygen is a better indicator of excess air for a wide range of fuels

Fig. 3 brings out the relation between excess air and the sum of CO_2 and oxygen in different fuels. In a carbon fuel having no available hydrogen, the CO_2 plus oxygen is equal to 20.9 per cent when there is no CO present. This condition is illustrated by the curve labeled "Coke." In fuels with available hydrogen a certain amount of oxygen combines with the hydrogen, forming water vapor, and thereby disappears from the ordinary gas analysis. This shrinkage increases with the percentage of available hydrogen in the fuel, so that with oil, natural gas and coke-oven gas the CO_2 plus oxygen is considerably below the figures with which one is familiar in analyzing flue gases from bituminous coal. Fig. 3 illustrates that the sum of CO_2 and oxygen is also limited as a direct indicator of excess air.

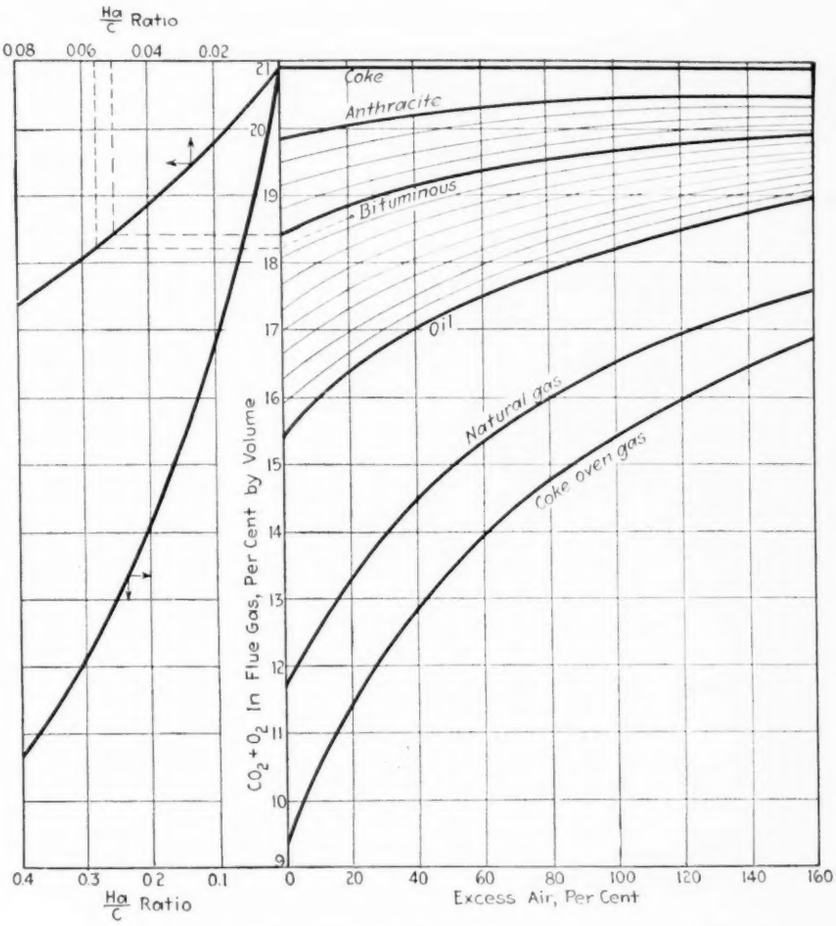


Fig. 3—This chart shows the relation between $CO_2 + O_2$ and excess air for various fuels

It is well to be on guard in checking gas analyses from different kinds of fuels to make sure that the samples were representative and that the analyses were properly made. While the curves given here are labeled "Oil," "Natural Gas," "Bituminous Coal," etc., they are not to be taken as truly representative of all such fuels, because any particular fuel of a given class having a different ultimate analysis, or rather a different ratio of available hydrogen and carbon, will give different results on this gas analysis basis.

The Flue-Gas Analysis as an Indicator of the Carbon Loss with Pulverized Fuel Firing

Suppose a coal having 79.86 per cent carbon and 4.04 per cent available hydrogen is burned in pulverized form. The available hydrogen-carbon ratio is 0.0506 per cent. If a flue-gas analysis from the combustion of this coal shows 15.16 per cent CO_2, 3.71 per cent oxygen, and 81.13 per cent nitrogen, then the percentage of excess air is 21, and from Fig. 3 it is found that this checks exactly on the curve marked "Bituminous Coal," and on the curves at the left checks the available hydrogen-carbon ratio of 0.0506 per cent.

Suppose, however, that the gas analysis had shown 14.96 per cent CO_2, 3.72 per cent oxygen and 81.32 per cent nitrogen. The excess air would figure the same, merely 21 per cent. But following this through from the curve would show a ratio of available hydrogen to carbon of 0.0560. From the ultimate analysis of the fuel it has already been seen that this ratio should be 0.0506. If we assume that all the hydrogen in the fuel is burned, which is likely to be true, then dividing the percentage of available hydrogen (4.04) by 0.0560 gives 72.14 as the percentage of carbon in the fuel that was actually

*Taken from Mr. Bailey's paper on "Limiting Factors in Reducing Excess Air." See *Mechanical Engineering* for July, 1926, and *Power* for July 13, 1926.

†President, Bailey Meter Co. and president, Fuller-Lehigh Co.

burned, and which was shown up in the gases as CO_2. This would indicate that 7.72 of the 79.86 per cent carbon in the fuel was lost as coke going to the ash-pit or as solid particles of carbon escaping in the flue gases.

It is obvious that with the burning of pulverized coal, if it is desired to determine the carbon loss accurately, careful flue-gas analyses must be made in order to measure this loss without the necessity of running complete boiler tests and thus determining it through the medium of unaccounted for loss in the heat balance. It is true that this will require more accurate gas analyses than we are accustomed to obtain with the Orsat apparatus. However, it is evidently worth while and should be given careful consideration.

One point that must be given attention in determining the gas analysis, is that of stratification of the gases. Gas samples taken from a stratum in which an abnormally large percentage of the hydrogen is being burned will give a lower total CO_2 plus O_2 than is normal for the fuel. An extreme case may approach a quantity about the same as is characteristic of coke-oven gas. On the other hand, if a sample is taken from the rear end of chain-grate stoker, the total CO_2 plus O_2 may run very high, approximating that of coke.

Production Tendencies in Europe

By Magnus W. Alexander
President, National Industrial Conference Board

AMERICAN mass production as a source of high "real wages" has captivated the minds of many European industrialists and economists to a point where it has become almost a fetish with them, and there is a widespread inclination to consider mass production a cure-all for all or many of Europe's economic ills.

Faced with an acute problem of under-consumption, European industrial and labor leaders are recognizing that the purchasing power of the wage-earning population must be increased. It is realized that mass production in America greatly increased the wage earners' purchasing power by increasing industry's output per worker and hence the latter's earnings, as well as reduced living costs. To embark on a program of mass production, however, would require ample capital and abundant, readily avaiable raw materials, the very two elements which in Europe are relatively scarce. On the other hand, Europe has an ample labor supply, evidently more than can be profitably employed under present conditions.

But mass production is not necessarily the one and only way of achieving the desired end, which is essentially that of lowering the production cost per unit of output. The abundance of raw materials and of capital, together with large domestic markets, in the United States, led to mass production as a natural development. But considering the comparably limited supply of raw materials and the relative scarcity of working capital in Europe, together with its ample labor supply, the task of European industrialists, as I see it, is to concentrate on quality production rather than quantity production. Production should be increased, to be sure, as markets broaden, but first of all unit-cost of production must be lowered by reducing overhead expenses and by improving technical processes. If in this manner production costs can be lowered sufficiently, not by reducing wages but by increasing industry's output per worker, it will make possible larger individual earnings per worker and domestic markets would improve because of the wage earner's increased purchasing power. Moreover, the manufactured products of the various European countries could, by virtue of the lowered cost of production, move more freely in foreign trade despite the many tariff barriers.

It is largely on the basis of such considerations as these that many of the post-war industrial consolidations in Europe have been and are being consummated. The new combinations, such as the gigantic new steel combine comprising the French, Belgian, German and Luxembourg steel interests, are intended to rationalize the industry by adjusting the productive capacity of the various member establishments to present markets and to the available working capital, by improving methods of production technically to the utmost degree, by producing fewer types of products but with a maximum degree of finish, and by concentrating the available resources on the works of greatest efficiency, closing down all others. In this manner the larger European industries, like the chemical, the electrical and the coal industry in Germany, and the international steel cartel, are striving for more profitable production by increasing the industries' output per worker. Another important object, however, is to strengthen their competitive position in foreign trade so that, by virtue of the lowered production cost, they may have more leeway in the matter of price.

The consolidation movement abroad is rarely looked upon as involving monopolistic tendencies, but rather as a concentration of industry. It will be well, of course, for the United States to keep a watchful eye on such mergers for evidence of tendencies toward world monopoly. There also is no use in closing our eyes to the fact that such mergers in some instances mean keener competition for American goods. But I believe we should not take too narrow a view of the ramifications of competitive foreign trade. A nation may expand its industry and commerce without necessarily doing so at the expense of other nations. I believe a busier Europe and expanding profitable European foreign trade will make Europe a better customer for American goods, and for the same reasons there need be no apprehension felt in Europe over the rapidly expanding scope of American foreign trade. Moreover, there are as yet vast regions representing great potential markets that are yet to be developed.

Interconnection Agreements Between Power Systems

Arrangements whereby electrical energy is interchanged were outlined in a paper by W. C. Bell at the recent Richmond meeting of the A.S.M.E. These can usually be placed in one of the three following general classes:

1. Those interconnections where a group of two or more companies tie their power systems together and pool the capacity available in order that electrical energy may be generated and distributed as though the interconnected systems were one large system.

In these cases an equitable arrangement as to division of cost has been suggested and used in certain cases, whereby each of the interconnected companies is either paid by the pool a capacity charge, based on the amount of excess capacity above its own requirements available for delivery to the pool, or pays to the pool a capacity charge based on the capacity required from the pool for its own uses.

In addition to the capacity charges, which are adjusted at reasonable intervals, each company is paid by the pool for any energy delivered at a rate per kilowatt-hour made up of the fuel cost per kilowatt-hour for the particular plant in question, plus a small amount per kilowatt-hour for labor and repairs. Any company receiving energy from the pool pays the pool for such energy at the average cost per kilowatt-hour of all energy delivered into the pool during the period in question.

2. Those interconnections where a group of two or more companies tie their systems together primarily for mutual protection and for interchange of surplus energy.

In these cases energy is usually interchanged when available, as needed, if agreeable at the particular time to both parties, with no obligation on the part of any of the interconnected companies to supply or to receive energy at any time.

Rates under such an agreement, often called the "when, as, and if" basis, are usually in the form of a flat rate per kilowatt-hour, high enough to cover ordinary opening charges of the seller, yet low enough to enable the purchaser to buy without seriously increasing his production costs.

3. Those interconnections which are made for the definite purpose of supplying capacity and energy to a company which prefers to buy a part or all of its requirements rather than to construct or increase its own generating facilities.

In these cases the purchasing company becomes a power customer, and standard power rates should control the rate at which the power is sold. Conditions arise to vary the direct status of buyer and seller, such as the availability on the system of the purchaser of a surplus of power during certain hours of the day and certain seasons of the year, sometimes called "dump power." This condition arises in case a company operates hydro-electric stations for the production of a part of its requirements, purchasing power during low-water periods and selling any dump power that may be available during good water periods.

Recent Publications

Hydraulics. By Joseph N. LeConte, Professor of Engineering Mechanics, University of California. Published by McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City, 1926. Cloth; 9x6 in.; 191 illustrations; 31 tables; 348 pages. Price, $3.

It has been the author's purpose to present in this book the theoretical principles of hydraulics. Such a treatment is necessarily mathematical. It is assumed that the reader is familiar with the calculus and elementary analytic mechanics and with the construction of hydraulic machinery. The use of empirical rules for solving hydraulic problems is avoided, so far as possible, and attention is paid to teaching the reader how to reason out the basic equations, as a groundwork for applying the more practical way of solving such problems.

The book is divided into three parts—hydrostatics, hydraulics and hydraulic machinery. Under hydraulics, a chapter is devoted to each of the following subjects: Hydraulics of a perfect liquid; the hydraulics of free discharge; the hydraulics of constrained discharge; problems involving the flow through closed conduits in series; divided or parallel flow; variable flow in pipes; flow in open channels; and the measurement of water. In Part III, which deals with hydraulic machinery, such subjects are included, as: Dynamic reaction of an open jet; the jet wheel, or kinetic-energy motor; the turbines; turbine performance under variable conditions; the centrifugal pump, and partial theory of the jet pump.

For the most part the treatment is analytic dealing with basic methods. For example, the treatment of the flow in open channels is entirely analytic, using Kutter's formula and the simple equation of flow $V=C\sqrt{rs}$, although all the examples worked through may be solved by graphic charts. For those wishing to be on familiar terms with the basic equations of hydrodynamics this book has much to recommend it. At the end of each chapter a number of problems and their answers are given, so that the reader may apply the principle set forth in the preceding chapter and check the results obtained.

Combustion (second edition). American Gas Association, New York. Paper cover, 9x11 in., punched for loose-leaf binder; 84 pages.

This volume is one of the Industrial Gas Series prepared under the direction of the American Gas Association, and is an excellent reference book on the theory and practice of the principles of combustion, with special reference to gaseous fuel. The book confines itself to practical information to enable and promote better industrial applications of gas. Standard texts and methods have been freely consulted and drawn upon, with appropriate acknowledgment. The book discusses the gas law corrections for temperature and pressure, the chemistry of combustion, the calorimetry and thermal capacity of gases, and the temperature of gas flames. A chapter is devoted to the analysis of furnace gases, and the volume closes with chapters on recuperation and regeneration, factors affecting the efficiency of utilization of gaseous fuels, and a final chapter on fuel comparisons.

The earlier chapters are applicable, with minor modifications, to the combustion of any fuel, and should be useful to anyone concerned with the generation of heat by combustion, since they comprise a brief and readily understandable statement of the underlying principles. The later chapters, referring more specifically to gaseous fuels, will be of interest not only to those who are already using such fuels, but also to users of other fuel to whom the methods of analysis and standards of comparison set up in this work may be of particular value.

The Evaporative Condenser. A Study of Heat Transmission by Film Evaporation. By David S. Anderson, Ph. D., B. Sc., A.R.T.C. of the Technical College at Derby, England. Reprinted from the Journal of the Royal Technical College for December, 1925. Size, 7x10 in.; 38 pages; illustrated.

The film evaporator is an apparatus in which the condensation of steam on one side of a metal surface heats a thin, flowing film of water on the other side of that surface, the heat of condensation being absorbed by the warming of the water, the evaporation of a portion of the water, and the warming of the overlying air, which may be circulated by gravity or fan. This reprint presents Dr. Anderson's analysis of the problem and the results of a rather extensive series of experiments conducted by him for the determination of the constants involved. The paper is highly technical and will interest only those who are concerned with the details of the design of film condensers or evaporators.

Mathematical and Physical Papers, 1903-1913. By Benjamin Osgood Peirce, late Hollis Professor of Mathematics and Natural Philosophy in Harvard University. Cambridge, Harvard University Press, 1926. Size 6½x9½ in.; 444 pages; illustrated. Price, $5.

This volume is a collection of practically all the papers published by Professor Peirce during the last ten years of his life, collected and edited by his former associates. The twenty-one papers, almost all of them devoted to the studies of the magnetization of iron and steel, present the results of experimental investigations together with detailed matematical treatment. The volume will doubtless be a valuable addition to the library of the mathematical physicist, and to the laboratory investigator in the field of magnetism, to whom the experimental results as set forth in tables and curves, together with the discussion of laboratory methods, will be of considerable value, whether or not the mathematics is within his grasp. As a memorial to Professor Peirce, the book will, of course, be prized highly by his former students and associates.

Business Annals. An attempt to summarize and depict the business conditions in seventeen countries, including the United States by years over an extended period in the country's history. By Willard L. Thorp and Wesley C. Mitchell, of the National Bureau of Economic Research, Inc., New York. Cloth; 6x9 in.; 380 pages. Price, $4.

No phase of business activities possesses more real interest to the executive and student of industrial operations than the study of the recurring "ups" and "downs" of business and industry, or what has come to commonly be known as the "business cycle." Its probable duration, and degree of prosperity and depression, if they could be foretold, would take much of the uncertainty out of business operations as they exist today. The comprehensive study of this subject, therefore, which has been made by Willard L. Thorp and just released by the National Bureau of Economic Research under the title "Business Annals," is a most welcome contribution to the science of modern business.

"Business Annals" is an attempt to summarize and depict business conditions in seventeen countries as they appeared to intelligent and expert observers. The tables and yearly business and economic analyses run back through a considerable period, those pertaining to the United States and England extending back yearly to 1790. Each year of this extended period is summarized as to economic conditions—industrial, commercial, labor, money, security, foreign exchange, agricultural production and prices—and is also reviewed as to various non-economic phenomena that may have exerted an influence upon the conditions of business.

This record of business conditions has been made especially valuable and attractive to the general reader by the inclusion of a chapter written by Wesley C. Mitchell, explaining and interpreting the basic record in considerable detail. The cyclical character of business fluctuation and the duration of these business cycles is thoroughly discussed. Counting the business cycles as the intervals between recessions, the author notes 32 business cycles in the United States in 127 years, which yields an average length of not quite four years. The commonest length is about three years, and two-thirds of the cases fall within the limits of three to four years. There is no indication that the average duration of business cycles is changing. The interesting fact is brought out that American business cycles have a shorter average duration than those of any other country studied.

For those interested in the study of business and industrial trends, in the probable extent of the present period of prosperity, and the period of decreased industrial activity which must follow, this book will prove of large interest.

News in the Field of Power

N.E.L.A. Appoints P. S. Clapp Managing Director

Following the resignation of M. H. Aylesworth as managing director of the National Electric Light Association, comes the announcement that Paul S. Clapp, of Washington, D. C., has been appointed executive head of that association. It is understood that Mr. Aylesworth relinquished the post to become president of the newly organized National Broadcasting Co., Inc.

Graduated from the Iowa State College at Ames in 1913, as a bachelor of science in electrical engineering, and ten years later attaining the professional degree of electrical engineer, Mr. Clapp has an excellent engineering ground work for the post he is to assume. In September, 1913, he found his first employment in the Chicago factory of the Western Electric Co., where he familiarized himself with factory methods.

Assisted in Research

In February, 1914, he advanced to the same company's engineering department in New York, remaining there until February, 1917, assisting in research work in connection with trials of the vacuum tube as an oscillator and amplifier, work that resulted in the first telephone conversation across the United States. Mr. Clapp was in charge of the station at Winnemucca, Nev., when the successful trial was made.

In February, 1917, Mr. Clapp became assistant purchasing agent of the Allied Machinery Corp., a subsidiary of the American International Corp., remaining until September of the same year, when he was commissioned a first lieutenant in the Signal Corps of the United States Army and became division signal supply officer of the Thirty-third Division at Camp Logan, Tex. Later, while in charge of the field trial and responsible for the final engineering approval of all radio and telegraph apparatus for airplanes, tanks and fields sets at the radio laboratories at Little Silver, N. J., he won promotion to a captaincy in the Signal Corps and was assigned by the War Department to organize and manage a factory in France for the assembly of all small-sized batteries used by the army. Complete plans for the factory were concluded, but the armistic halted the work before it was put into operation.

Served Relief Commission

From December, 1918, to February, 1919, Mr. Clapp served on the peace commission in Paris, and afterward he was affiliated with the American Relief Administration for central and southeastern Europe, which established and supervised the operation of telegraph and telephone service between various cities in Europe from which relief work was administered, including cities in Austria, Italy, Poland, Germany, Jugoslavia, Rumania, Czechoslovakia and Hungary. After finishing that work, Mr. Clapp assisted in re-establishing cordial relations in the business interchange between American and western

Underwood & Underwood

Paul S. Clapp

European industries and then sailed with Col. William Haskell and his original American Relief Administration party from New York to Russia.

Concluding his work with the Relief Administration in February, 1923, Mr. Clapp traveled in Scandinavia and central Europe and then in Berlin to study languages, customs and conditions. Returning to this country, Mr. Clapp, who had aroused the interest of Herbert Hoover when the latter was in charge of the American relief work in the Old World, was appointed special assistant to the Secretary of Commerce in engineering, economic and commercial problems of the United States.

Chicago-Milwaukee Engineers Visit Allis-Chalmers

A joint inspection trip by Chicago and Milwaukee engineers through the plant of the Allis-Chalmers Manufacturing Co., followed by a dinner at the Milwaukee Athletic Club, was the first step in a concerted effort to bring together engineers of varied interests in the Middle West for the purpose of making and renewing acquaintances and through it all establishing better fellowship among the various engineering societies.

On Oct. 8 a special four-car train on the North Shore line carried over 180 engineers to Milwaukee, the group being affiliated with the Western Society of Engineers and the Chicago sections of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. Stops were made en route to inspect one of the new automatic substations, the overhead transmission and an interlocking tower of unusual range. At the plant a complimentary luncheon was served in the company clubhouse, and in company with a number of Milwaukee engineers, the entire afternoon was devoted to the trip through the plant, which was conducted by heads of departments and the engineering staff.

The shops were unusually full of a great variety of large and instructive work. Large mining hoists, crushers, band mills, pumps, solid cast runners, the new 50,000-kw. tandem two-cylinder turbo-generator for the Waukegan plant and its immense condenser containing 57,000 sq.ft. of surface, a 7,000-hp. direct-current motor and a 4,000-kw. gas engine for the steel mills, Corliss engines, some of the new armor-clad switch gear, and a large collection of high-voltage transformers were a few of the many attractions.

Features in the foundry were a demonstration of the hydraulic cleaning of castings, the special molding machines and the pouring of the immense cylinders for the 4,000-kw. gas engine.

Interesting Turbine Runners

Of particular interest were the patterns for the runners of the four 54,000-hp. hydraulic turbines intended for the Conowingo development of the Susquenhanna Power Co. Each runner is to be made in three pieces of cast steel and when completed will weigh approximately 200,000 lb. These units will be equipped with butterfly valves 27 ft. in diameter, the largest ever made. They will be placed at the same level as the turbine casing and are designed for an operating head of 85 ft. A unique feature of the design is a rubber sealing device composed of a rubber tube of 2 in. inside diameter and walls ½ in. thick, which will be set in a recess in the housing. When the wicket has been closed, pressure will be introduced inside of the rubber tube, causing it to expand against the edge of the wicket and thus making a tight seal.

To round out the day, a joint dinner and short meeting at the Milwaukee Athletic Club was tendered by the Engineers Society of Milwaukee. In an attendance of two hundred many representative engineers were present. President Fred C. Trubshaw welcomed the delegation, and he was followed by a number of speakers, including B. J. Jamieson, one of the vice-presidents of the fifth district of the American Institute of Electrical Engineers; Fred Dorner, past-president of the Engineers Society of Milwaukee, and Edgar S. Nethercut, secretary of the Western Society of Engineers.

Noted Experts on Fuel Oil To Lead Coal Conference

The anticipated presence and addresses of Dr. Friedrich Bergius and Prof. Franz Fischer, of Germany, and Gen. Georges Patart, of France, attending the International Conference on Bituminous Coal at Carnegie Institute of Technology in Pittsburgh, Nov. 15-19, is responsible for much of the interest that has been aroused over the coming congress.

Dr. Bergius is best known as the inventor of the Bergin method of the production of oil from coal. Professor Fischer is Director of the Institute of Coal Research at Mulheim-Ruhr, and General Patart who was in charge of the manufacture of explosives during the war, is the inventor of a process for making methyl alcohol from coal.

"The methods produced by Fischer and Bergius," President Thomas S. Baker points out, "are widely different. Neither produces oil as a byproduct. Each utilizes completely or nearly completely, the original matter. Fischer reduces coal to a gaseous form and then by means of a catalyst liquefies the gases. He is able to produce methanol, which seems to possess all the qualities of wood alcohol; synthol, which is equivalent to high-grade gasoline; and receently, he has manufactured a substitute for benzine. Bergius reduces the coal to a paste and at a very high temperature and at high pressure combines it with hydrogen. The resulting fluid has all the properties of crude petroleum and must be treated in the same way in order to obtain gasoline and the other products of crude oil.

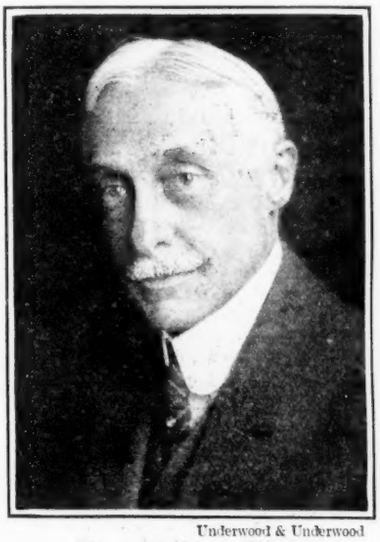
"The French scientist, General Patart, has also done important work in the liquefaction of coal along similar lines to those pursued by Fischer. In fact it has been claimed that the methods are so similar that the question of priority has been the subject of some discussion. The French scientist secures a substitute for wood alcohol. His process is being utilized commercially, and the right to use it in this country has been secured by one of the great American chemical companies. Fischer's process is controlled by a great German company, and large quantities of methanol have been shipped to this country from Germany, so much in fact as to menace the wood alcohol industry.

The program for the meeting, it is announced, will include the discussion of the manufacture of substitutes for gasoline from coal, complete gasification of coal, high-temperature distillation, low-temperature distillation, coal-tar products, power, smokeless fuel, fertilizers, etc. Emphatic announcement is made that questions in connection with the mining of coal, the economics of coal, labor problems, and engineering problems will not be discussed. The conference, President Baker points out, will be concerned chiefly with the best methods of the utilization of coal and with the discussion of new ways of employing coal.

In addition to Fischer, Bergius and Patart, the speakers will include other European scientists and a large number of American engineers and chemists.

Elmer Ambrose Sperry Named for John Fritz Medal

For his pioneer work, remarkable research accomplishments and numerous inventions in the early field of electricity and his more recent work in the development and application of the gyroscope and also because of his prominent position among leading engineers in general, Elmer Ambrose Sperry was nominated recipient of the John Fritz Medal at the annual meetings of the John Fritz Medal Board of Award and



Underwood & Underwood

Elmer Ambrose Sperry

the John Fritz Medal Fund Corp., held at the Engineers Club, New York City, Oct. 15.

Mr. Sperry was born Oct. 12, 1860, at Cortland, N. Y., where he later studied at the State Normal and Training School and then entered Cornell University in 1879. The following year he founded the Sperry Electric Co. in Chicago for the manufacture of arc lamps, dynamos, motors and other electric appliances, having invented one of the earliest types of arc lamps during his single year in the university. The Sperry Electric Railway Co., which he also established, was sold to the General Electric Co. in 1894.

But as the inventor of the gyroscope for the stabilization of ships, and later aeroplanes, he is most noted in recent years. Fire control apparatus, and numerous special devices, many of which are used by the United States Navy, the erection in 1883 of the highest electric beacon in the world on Lake Michigan, and the holding of over 400 patents issued in the United States and Europe has established the name of the president of the Sperry Gyroscope Co., Brooklyn, N. Y., which Mr. Sperry established in 1910 for the manufacture of his inventions.

The John Fritz Medal follows many awards of note, among them First Prize Aero Club of France, 1914, the Franklin Medal, 1914; the Grand Prize for the Gyro-compass and Gyroscopes, San Francisco, 1915; Collier Trophy, 1916; Scientific American Medal; Decorations by ex-Czar Nicholas of Russia and the Emperor of Japan. He is a member of the A.I.E.E., A.S.M.E. and many other technical and social organizations.

Following the members' dinner, the Board of Award received his name and agreed upon the nomination. The meeting of the Corporation and its Board of Directors then went into session.

The members of the Board which awarded the medal for 1927 were: American Society of Civil Engineers: John R. Freeman, Charles F. Loweth, C. E. Grunsky, Robert Ridgway, American Institute of Mining and Metallurgical Engineers: Charles F. Rand, Arthur S. Dwight, William Kelly, J. V. W. Reynders; American Society of Mechanical Engineers: Fred J. Miller, Henry B. Sargent, Fred R. Low, W. F. Durand; American Institute of Electrical Engineers: Frank B. Jewett, Gano Dunn, Farley Osgood, M. I. Pupin.

The presentation of the medal to Mr. Sperry will take place at 8:30 Tuesday, evening, Dec. 7, in the Engineering Auditorium, 29 W. 39th St., N. Y. C., in connection with the annual meeting of the A.S.M.E.

Refractories Institute Will Hold Technical Program

The regular fall meeting of the American Refractories Institute will be held at the University Club, Pittsburgh, Pa., Oct. 21, convening at 10:30 am. A luncheon will follow the meeting, at which there will be several speakers.

For the technical program it has been arranged to have the following men present: Prof. Gordon B. Wilkes, Massachusetts Institute of Technology, Cambridge, Mass.; R. F. Geller, Bureau of Standards, Washington, D. C.; Samuel J. McDowell, Superintendent, Bureau of Standards, Columbus, Ohio and L. E. Hankinson, West Penn Power Co., Pittsburgh, Pa.

In addition, Stuart M. Phelps, director of research and tests of the Refractories Fellowship, Mellon Institute, Pittsburgh, Pa., will present a paper on "Plastic Refractories." It is also planned to devote part of this meeting to open discussion of the various papers presented.

Non-members are invited to attend this meeting. Further information may be had from the secretary, Miss Dorothy A. Texter, 2202 Oliver Building, Pittsburgh, Pa.

Quebec and Ontario Join in Mutual Project

An agreement has been reached between the provinces of Quebec and Ontario whereby the Carillon waterfalls on the Ottawa River will be developed immediately. The governments of the two provinces have agreed to sign a contract with the National Hydro Co., and both provinces will share equally in the development.

Present estimates are that the Carillon falls will develop 266,000 hp., and the estimated cost of the work is approximately $35,000,000. The plans of the development and exploitation will be carried out by the private interests concerned. The information is that the Aldred Shawinigan group are looking afer the necessary arrangements and will also dispose of the power.

Premier Ferguson of Ontario has announced that the proposed development will add to Ontario's reserve of hydroelectric energy something like 133,000 horsepower.

Western Pennsylvania Power Companies Acquired

The Associated Gas & Electric System announced today the acquisition of additional properties in western Pennsylvania. Chief among them are the Myersdale Electric Light, Heat & Power Co. and affiliated companies; Citizens' Light, Heat & Power Co., and Summit Township Electric Light, Heat & Power Co. The larger communities served by these properties are Meyersdale, Garrett, Elks Lick, Salisbury, Pa., and Grantsville, Md.

May Hold Next World Power Conference in United States

While Italy has the first call on the next session of the World Power Conference in 1930, there is a possibility that the Italian power industry may find it desirable to entertain that congress at a later time. In such an event the 1930 meeting would be held in the United States.

The Basel meeting drew a much larger attendance than had been anticipated. The French had a larger delegation at the sectional meeting than they had at the London meeting in 1924.

More than 100 German delegates were in attendance. Most of the technical societies in Germany were represented.

Builds Largest Direct Current Motor

The world's largest direct current motor of 8,000 hp. capacity has just been shipped from the Westinghouse Electric & Manufacturing Co.'s plant at East Pittsburgh, Pa.

The motor has a total weight of 625,000 lb. The over-all length of the shaft is 26 ft. 8 in., and the frame has an outside diameter of 20 ft. It is capable of developing a maximum capacity of 2,400,000 ft.-lb., which at 40 r.p.m. is equivalent to 18,300 hp.

It obtains its power from a flywheel set which consists of two 3,500-kw., 70-volt generators operating at 375 r.p.m. Three 50,000-lb. flywheels are used to equalize peak loads. The set is driven by a 5,000-hp. induction motor. The over-all length of this set is 48 ft. 8 in.

Italy Subsidizes Her Steam Power Plants

The Italian Government has issued a decree granting subsidies for the construction of steam power plants consuming domestic fuel which are begun within five years of the issuance of the decree, according to Assistant Commercial Attache A. A. Osborne, Rome, in a report to the Department of Commerce.

The subsidy rates are variable but may not exceed 50 lire (about $2) per kilowatt installed, depending upon how much domestic equipment is used. A further operating subsidy not exceeding 5 centessimi per kilowat-hour generated may be allowed. Subsidies will not continue beyond ten years from the commencement of operation.

Deneen and Jadwin Visit Muscle Shoals

The large development on the Tennessee River was recently visited by Senator Deneen, of Illinois, and Major General Jadwin, chief of engineers, for the purpose of inspecting the dam, power house, the electrical nitrate plant and the site of proposed dam Number 3.

According to General Jadwin only a small portion of the water is now being used for power development. This means that the power needs of the Alabama power companies have generally declined since a maximum of 2,200,000 was attained early in June.

Conowingo Costs Report Now Submitted to Commission

The Joint Accounting Committee of Maryland and Pennsylvania which has been working on the pre-license costs of Conowingo project has submitted its report to the Federal Power Commission. The report is voluminous and has required nine months of exacting work. It has been necessary to examine literally thousands of accounts running back over a period of fifty years.

Correction is here made of an error appearing in "Delivery by Plane Keeps Power Plant Running," which was printed in the Sept. 7 issue on page 386. Attention is called to the fact that Bend, Ore., is 236 miles, by auto, from Portland, and not 600 miles by rail over the Rocky Mountains or by air route 270, as the distances were stated.

Obituary

C. A. Chapman, consulting mechanical and electrical engineer, specializing in the building of industrial plants, died on Sept. 20, as a result of a major operation. He was born at Copley, Ohio, in 1875. About 1892 he began his career as architect and engineer at Akron, Ohio, going from there to the Walker Manufacturing Co., of Cleveland, and later becoming affiliated with the Akron Street Railway Co. as engineer to reconstruct the power plant at Akron.

In December, 1896, Mr. Chapman came to Chicago to go with Naugle, Holcomb & Co. to take charge of design and construction of the Suburban Railway power plant at Harlem Ave. and 22nd St. Becoming identified with B. J. Arnold a little later on, he was given charge of the design and construction of the Imperial Electric Light Co. plant at St. Louis. Returning to Chicago in 1899, he opened an office for himself. The business was incorporated as C. A. Chapman, Inc., in 1908, and since than has continued under that name.

In an engineering capacity Mr. Chapman has been identified with many large industrial and public service properties throughout the country. The twine mill of the McCormick Harvester Co., now known as the International Harvester Co., was an outstanding plant for the design of which he was responsible.

Mr. Chapman was a thirty-second degree Mason and also a member of the Union League Club, of Chicago. He served his home village of Western Springs as its president for eight years, and at the time of his death was a director in the Western Springs State Bank and the Western Springs Building & Loan Association.

George K. Elliott, chief chemist and metallurgist of the Lunkenheimer Co., Cincinnati, Ohio, died at the Christ Hospital, Cincinnati, Sept. 23, following an operation. He was born at Sidney, Ohio, in the year of 1881. He graduated from the University of Cincinnati and taught science for a while before entering the employ of the Lunkenheimer Co.

Mr. Elliott is responsible for the development of the duplex process for cast iron which involves the use in tandem of the cupola and the electric furnace. He has described for the American Foundrymen's Association in a number of papers, the metallurgy of cast iron in the electric furnace. He also contributed a number of articles to scientific journals in America and Europe.

Mr. Elliott was past chairman of the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineering, past vice-president of the American Electrochemical Society and past chairman of its electrothermic division. For a number of years he served on the nonferrous metals advisory committee of the Bureau of Standards and also belonged to the Sigma Xi honorary scientific society. He was also a member of the American Chemical Society, American Society for Testing Materials, Society of Chemical Industries, Automotive Engineers and the American Foundrymen's Association.

Personal Mention

Owen R. Rice has recently resigned his position as assistant blast-furnace superintendent of Maryland Plant, Bethlehem Steel Corp., to become associated with Freyn Engineering Co.

William J. Massey, plant engineer at the Chevrolet Motor Co., Detroit, Mich., has resigned to become chief engineer and superintendent of the new Statler Hotel and Office Building, Boston, Mass.

Samuel P. Hunt has resigned as mechanical engineer of the Barstow Management Association, Reading, Pa., to become engineer and executive with the Manchester Traction, Light & Power Co., at Manchester, N. H.

M. C. Sherman has resigned as president of the Allen-Sherman-Hoff Co. and has discontinued his connections with the company on account of the demands of other interests. His address now is care of Sherman Engineering Co., 254 South 15th St., Philadelphia.

Sir Alfred Mond, chairman of the board of the Mond Nickel Co., Ltd., London, Brunner, Mond & Co., London, Victoria Syndicate, Ltd., of Canada, Henry Wiggins & Co., London, and the Amalgamated Anthracite Co., Swansea,

South Wales, has returned to England after a month's visit in the United States and Canada.

Joseph H. Ehlers has filled the post of Engineering Trade Commissioner at Tokyo, Japan, as the representative of the Bureau of Foreign and Domestic Commerce.

The appointee has had extensive experience as an engineer in the Far East. In connection with the Yellow River project in China, he joined the Asia Development Co. For a time he was also editor and publisher of an engineering magazine devoted to promotion of American and Chinese cooperation in development projects and served as honorary counsellor to the Chinese Ministry of Communications.

Society Affairs

The A.S.M.E., Metropolitan Section, will hold a joint meeting with the New York Section of the American Society of Civil Engineers at the Engineering Societies Bldg., 29 West 39th St., New York City, Oct. 20, at 8 p.m. The subject of "Foundations" will be treated by Lazarus White, president, Spencer, White & Prentis, Inc. The topic will be discussed from the point of view of the mechanical engineer by Robert A. Marshall.

Business Notes

The G. W. Brogan Co. Inc., Towson, Md., has been retained as advertising and merchandising counsel for the American Hammered Piston Ring Co., Baltimore, Md., effective Oct. 1, 1926.

The Graybar Electric Co. announces the change in location of the local uptown wholesale distributing store, effective Nov. 15, from 105 West 40th St. to larger accommodations at 231-235 East 42nd St., New York City.

Leland Brooks, formerly vice-president and treasurer of the Franklin Railway Supply Co. Ltd., Montreal, has been appointed special representative of the Worthington Pump & Machinery Corp. with headquarters at Chicago. In addition to other duties Mr. Brooks will handle railroad sales in Canada.

The Power Specialty Co. recently opened an additional branch office to extend its service to users of Foster convection and radiant heat superheaters, economizers and water-cooled furnaces, and the Aero unit coal pulverizer. This office is located in 709, Security Bldg., 209 Grant Ave., Milwaukee, Wis.

The Foote Bros. Gear & Machine Co. of Chicago, report that J. M. Allen has recently joined the company's factory organization as manager of production. He was manager of production of the Mosler Safe Co., Hamilton, Ohio, for five years, and manager of production and traffic for the Goldsmith Metal Lath Co., Cincinnati, Ohio, for about one year, which position he left to accept his new position with the Foote Bros. Gear & Machine Co.

The Carborundum Co. of Niagara Falls, N. Y., manufacturer of abrasive products, announces the appointment of W. J. Ulrich as district sales manager of the coated abrasive sales division in the Detroit territory. Mr. Ulrich will have complete charge of the sales of Carborundum Brand Garnet Paper and Cloth, Carborundum Paper and Cloth, Aloxite Paper and Cloth and the Carborundum Brand Waterproof Finishing papers in the above-mentioned district.

Coming Conventions

American Engineering Council. Annual meeting at Washington, D. C., Jan. 13-15. L. W. Wallace, 24 Jackson Place, Washington, D. C.

American Welding Society. Annual Fall Meeting, at Buffalo, N. Y., Nov. 16-19. Gideon W. Swan, general chairman, Morgan Bldg., Buffalo, First International Welding Exposition will be held in conjunction with meeting.

Engineering Institute of Canada. Annual meeting Jan. 18. Richard John Durley, secretary, 176 Mansfield St., Montreal, Que.

Chicago Power Show, at Chicago, Feb. 15-19. G. E. Pfisterer, managing director, 53 West Jackson Blvd., Chicago.

National Association of Practical Refrigerating Engineers. Annual Convention and Exhibition at Kansas City, Mo., Nov. 2-5. Edward H. Fox, secretary, 5707 W. Lake St., Chicago, Ill.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Annual convention at Atlantic City, week beginning June 6.

National Exposition of Power and Mechanical Engineering. Fifth Annual Exposition at Grand Central Palace, New York City, Dec. 6-11.

National Marine Engineers' Beneficial Association. Fifty-third annual convention at Washington, D. C., Feb. 14. Albert L. Jones, secretary-treasurer.

Trade Catalogs

The Silent Hoist Winch & Crane Co., of Brooklyn, N. Y., announces the removal of the works and general offices to its new building, 762-772 Henry St., Brooklyn, N. Y.

Engines — Nordberg Manufacturing Co., Milwaukee, Wis., has issued a 28-page bulletin, No. 41, devoted to the company's line of uniflow steam engines. Principles of operation, power and heating, operating condensing or against a back pressure, are discussed previous to a description of details.

Rotary Displacement Meters—The Connersville Blower Co., manufacturer of rotary positive pressure blowers, gas exhausters and pumps. Another bulletin on the Connersville rotary displacement meter for measuring air or gas. This one is No. 43, illustrating a few of the special arrangements in which these meters can be supplied.

Pulley Data—Harry M. Perry, manufacturer of Belt-Slacker and slack belt drives for any position, Los Angeles, Calif., has issued a folder on new pulley H. P. data. Copies will be mailed to any engineer on request.

Wrought Iron Pipe—The Reading Iron Co., Reading, Pa., Bulletin No. 2 contains Reading pipe service records of interest to the consumer. There are four pages in the book of especial note, and on them are the two articles, "Two Ways To Be Sure of Genuine Wrought Iron Pipe" and "From Puddling Furnace to Installation."

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Oct. 11 1926
Pool 1	New York	$2.75@$3.00
Smokeless	Boston	3.11
Clearfield	Boston	2.15@ 2.75
Somerset	Boston	1.90@ 2.10
Kanawha	Columbus	1.75@ 2.15
Hocking	Columbus	1.40@ 1.75
Pittsburgh	Pittsburgh	2.00@ 2.15
Pittsburgh gas slack	Pittsburgh	1.45@ 1.55
Franklin, Ill.	Chicago	2.35@ 2.50
Central, Ill.	Chicago	2.15@ 2.25
Ind. 4th Vein	Chicago	2.15@ 2.35
West Ky.	Louisville	1.15@ 1.50
S. E. Ky.	Louisville	1.60@ 1.90
Big Seam	Birmingham	1.75@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	2.15@ 3.50
Buckwheat No. 1.	Philadelphia	2.25@ 3.00
Birdseye	New York	1.40@ 2.00

FUEL OIL

New York—Oct. 14, light oil, tank-car lots; 28@34 deg. Baumé, 6c. per gal.; 36@40 deg., 6¾c. per gal. f.o.b. Bayonne, N. J.

St. Louis—Oct. 6, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.15 per bbl.; 26@28 deg., $2.20 per bbl.; 28@30 deg., $2.25 per bbl.; 30@32 deg., $2.30 per bbl.; 32@36 deg., gas oil, 6.1c. per gal.; 38@40 deg., 7.5c. per gal.

Pittsburgh—Oct. 5, f.o.b. local refinery; 30@34 deg., fuel oil, 5¾c. per gal.; 36@40 deg., fuel oil, 6½c. per gal.

Dallas—Sept. 22, f.o.b. local refinery 26@30 deg., $1.70 per bbl.

Philadelphia—Oct. 9, 27@30 deg., $2.52@$2.58 per bbl.; 13@19 deg., $1.59 @$1.65 per bbl.

Cincinnati—Oct. 12, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Oct. 9, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.40@$1.45 per bbl.; 26@30 deg., $1.50@$1.55; 30@32 deg., $1.75.

Boston—Oct. 4, tank-car lots f.o.b. 12@14 deg. Baumé, 4.8c. per gal.; 28@32 deg., 6c. per gal.

New Plant Construction

Calif., Merced—Merced Irrigation Dist., Barcroft Bldg., will receive bids until Oct. 26 for the installation of drainage pumps and motors (complete).

Calif., Oakland — Medico-Dental Bldg., Assn., c/o F. H. Reimers, Tribune Tower Bldg., awarded contract for the construction of a 12 story office building at 17th and Franklin Sts. to Starr, Thebo & Anderton, Sharon Bldg., San Francisco. $500,000.

Calif., San Diego—San Diego Medical-Dental Assn., c/o F. W. Stevenson, Archt., is having plans prepared for the construction of a 14 story office building at 3rd and A Sts.

Ill., Chicago — A. Karsas, 32 West Randolph St., awarded general contract for the construction of a 12 story hotel and theatre building at 63rd St., Maryland Ave. and Drexel Blvd. to Longacre Construction Co., 127 North Dearborn St. Estimated cost $5,000,000.

Ill., Chicago—L. J. Mensch, 160 North La Salle St., is having plans prepared for the construction of a 15 story apartment at 1530 North State Parkway. Estimated cost $1,000,000.

Ill., Chicago—P. T. Johnstone, 190 North State St., Archt., will receive bids about Oct. 25 for the construction of a 6 story hospital at 6542-6614 Ridge Ave. for Ridge General Hospital. Estimated cost $1,500,000.

Ill., Chicago—State Bank of Chicago, 133 West Washington St., awarded contract for the construction of a 22 story bank and office building at La Salle and Monroe Sts. to Lanquist Construction Co., 1100 North Clark St. Estimated cost $3,000,000.

Ill., Chicago—Wm. Wallen, Jr., 6712 North Clark St., awarded contract for masonry, etc. for a 17 story apartment at 405 Fullerton Pkwy. to Shellburg Construction Co., 6712 North Clark St. Estimated cost $1,500,000.

Ill., Rockford—Peoples Bank & Trust Co., F. F. Wormwood, Pres., is having preliminary plans prepared for the construction of a 10 or 12 story bank and office building at State and Main Sts. Estimated cost $2,000,000.

Ind., Evansville—Hiller & Anderson, c/o Dept. of Waterworks, Cincinnati, O., have submitted report recommending waterworks improvements including reservoir, two pumps, coal handling equipment, trunk line to reservoir, etc. Estimated cost $1,270,000.

Ia., Emerson—City, P. A. Carson, Clk, will receive bids until Oct. 25 for improvements to waterworks including 60 g.p.m. single stroke deep well pump at 30 crank r.p.m., 100 g.p.m. two stroke deep well pump at 30 crank r.p.m., 15 hp., 3 ph., 220 v. 1120 r.p.m., a.c. motor, 40,000 gal. tank on 60 ft. tower, etc. Estimated cost $23,750. Henningson Engineering Co., National Bldg., Omaha, Neb., is engineer.

Kan., Ft. Scott—City plans improvements to waterworks including pumps, etc. Estimated cost $25,000. R. Toles is city engineer.

Kan., Salina—City is having plans prepared for the construction of a sewage disposal plant and pumping station. Estimated cost $125,000. Haskins & Crawford, 822 Finance Bldg., Kansas City, Mo., are engineers.

Me., Bangor—Treasury Dept., Washington, D. C., will receive bids until Nov. 2, for furnishing and installing a deep well pumping plant, etc., in U. S. Post Office here.

Mass., Lynn — Commission of Ways & Drainage will receive bids until Nov. 9 for the construction of a sewage pumping station. Morris Knowles, Inc., 507 Westinghouse Bldg., Pittsburgh, Pa., is engineer.

Mass., Worcester—Municipal Water Dept. plans improvements to waterworks including pumping equipment to pump from Pine Hill reservoir to Beaver Brook playgrounds, also to put into commission old pump at Metropolitan reservoir. Estimated cost $70,000.

Mich., Detroit—Comstock Investment Co., 1313 Dime Bank Bldg., is having plans prepared for the construction of a 30 story office building including steam heating equipment, elevators, etc. at Woodward and Jefferson Aves. Estimated cost $10,000,000. B. C. Wetzel & Co., 2317 Dime Bank Bldg., are architects.

Mich., Jackson—Weary & Alford, 1923 Calumet Ave., Archts., will receive bids about Nov. 1 for the construction of a 13 story bank and office building for Jackson City Bank. Estimated cost $500,000.

Mich., Ypsilanti—Ford Motor Co., Highland Park, awarded contract for the construction of a hydro-electric plant and dam on Huron River here, to Stone & Webster, Inc., 147 Milk St., Boston, Mass.

Neb., Beatrice — Black Bros. is having plans prepared for the construction of a hydro-electric plant including power house and dam. Estimated cost $150,000. Private plans.

Neb., Blair—City Council will receive bids until Oct. 29 for improvements to waterworks including two 300 g.p.m. horizontal single stage centrifugal pumps direct connected to 25 hp., 3 ph., 220 v. motors, two 300 g.p.m. horizontal 2 stage centrifugal pumps direct connected to 3 ph., 220 v. motors, etc. Henningson Engineering Co., National Bldg., Omaha, is engineer.

N. J., Atlantic City—Virginia Hotel Corp., awarded contract for the construction of a 15 story hotel at Virginia Ave. and Broadwalk to Taylor Meyer Co., Keystone Bldg., Pittsburgh, Pa.

N. J., Jersey City—B. Carminsky, c/o Shape, Bready & Peterkin, 285 Madison Ave., New York, N. Y., Archts., awarded contract for the construction of a 5 story apartment at Hudson County Blvd. here to Deakman Wells Co., 921 Bergen Ave., Jersey City, N. J. Estimated cost $750,000.

N. J., Jersey City—New Jersey Bergen Square Realty Co., H. S. Kerbaugh, Pres., will build a 16 story theatre and office building at Hudson Blvd. and Journal Sq. Estimated cost $2,500,000. Work will be done by separate contracts under the owner's supervision.

N. Y., New York—Allerton Operating Corp., W. S. Silk, Secy., 285 Madison Ave., is having plans prepared for the construction of an 18 story hotel including steam heating system, 8 electric elevators, etc. at 63rd and Lexington Ave. Estimated cost $4,000,000. Murgatroyd & Ogden, 285 Madison Ave., are architects.

N. Y., New York—Central Union Trust Co., W. S. Gray, 80 Broadway, plans the construction of a 43 story bank and office building at Broadway and Wall St. Estimated cost $12,000,000. Architect not selected.

N. Y., New York—Consolidated Gas Co., Irving Pl., is having plans prepared for the construction of a 26 story office building including steam heating system, 8 electric elevators, etc. at Irving Pl. and 14th St. Estimated cost $6,000,000. T. E. Murray, 55 Duane St., is architect and engineer.

N. Y., New York—C. G. Edwards Syndicate, 93 Worth St., awarded contract for the construction of a 17 story office and loft building on Worth St. to G. Richard Davis & Co., Inc., 10 East 41st St. Estimated cost $6,000,000.

N. Y., New York—F. Leder, 188 Montague St., Brooklyn, is having plans prepared for the construction of a 15 story hotel including steam heating system, 4 electric elevators, etc. on West 45th St. here Estimated cost $750,000. W. I. Hohauser, Inc., 1400 Broadway, New York, is architect.

N. Y., New York—H. Mandel c/o V. C. Farrar, 1 Park Ave., will soon receive bids for the construction of a 20 story apartment including 6 electric elevators at 109 East 50th St. Estimated cost $1,500,000.

N. Y., New York—J. Siskowitz, 1440 Broadway, awarded contract for the construction of a 14 story apartment at 261 Central Pk. W. to S. S. Roth & Sons, 1440 Broadway. Estimated cost $3,000,000.

O., Crooksville—Village plans an election in Nov. to vote $96,000 bonds for the construction of a waterworks system including deep wells, pumping station, storage tank, etc.

O., East Cleveland (Cleveland P.O.)—The Eddy Road Euclid Co., L. B. Konblitz, 1022 Leader Bldg., Cleveland, awarded contract for the construction of a 4 story stores building including electric refrigeration system, incinerator, etc. at 13741 Euclid Ave. here to Gometz & Neshkes, 2233 East 89th St. Estimated cost $300,000.

O., Gallipolis—City Commission, A. W. Davis, Pres., plans an election in Nov. to vote $105,000 bonds for the construction of an electric light plant.

O., Mansfield—Ohio Brass Co., awarded contract for the construction of a 5 story office building to Hossler Bros., Tiffin. Estimated cost $500,000.

O., Summitville—H. & G. T. Landrum, 2373 East Maund St., Columbus, is in the market for machinery for new shale plant including 4 or 5 electric motors.

Okla., Authers—City plans an election Oct. 19 to vote $25,000 bonds for the construction of a new filtration plant and pumping equipment. Gantt-Baker Co., 1116 West Main St., Oklahoma City, is engineer.

Okla., Miami—J. F. Robinson, has been granted permit by the Corporation Commission to construct a 269,000 hp. hydro-electric project on the Grand River. Estimated cost approximately $7,000,000 exclusive of land and transmission lines. R. D. Salisbury, Denver, Colo., is engineer.

Okla., Seminole—Western Ice & Cold Storage Co., c/o Oklahoma Utilities, Local Bldg., Oklahoma City, has been granted permit for the construction of a 20 ton ice plant here. Estimated cost $40,000. Engineer not selected.

Pa., Philadelphia—Herman & Bobbs, 4945 Sansom St., plans the construction of a 6 story apartment on Pine St. Estimated cost $1,000,000. Stetler & Dysher, Jefferson Bldg., are architects.

Pa., Pittsburgh—University of Pittsburgh, J. G. Bowman, Chancellor, awarded contract for the construction of a 33 story cathedral of learning at Bigelow Blvd. & Forbes St. to Stone & Webster, Inc., 147 Milk St., Boston, Mass. Estimated cost $7,000,000.

S. D., Pierre—Bd. of Commissioners, J. H. Starkey, Auditor, will receive bids until Nov. 3 for furnishing and installing a 1,050 g.p.m. motor driven deep well centrifugal pump. Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo., are engineers.

Tenn., Columbia—Southern Cities Power Co., Provident Life Bldg., Chattanooga, awarded contract for the construction of a power house and dam on Duck River here, to Gould Contracting Co., Independent Bldg., Nashville. Estimated cost $75,000.

Tenn., Lebanon—Interstate Ice & Coal Co., plans to rebuild ice plant recently destroyed by fire. Estimated cost $150,000.

Tex., Victoria—City Commission, will receive bids until Nov. 1 for improvements to waterworks including pump house, centrifugal pumps, boilers, etc. Estimated cost $60,000. Terrell-Bartlett Engineers, Calcasieu Bldg., San Antonio, are engineers. S. S. Sitterle, mayor.

Wis., Fond du Lac — Canvas Products Corp., 19 East McWilliams St., is in the market for motors, etc., for proposed addition to factory.

B. C., Victoria—C. E. Watkins, Green Bl., Archt., will receive bids until Oct. 26 for the construction of a 4 story hospital including power house, etc. for St. Joseph's Hospital. Estimated cost $300,000.

Ont., Hamilton—Browning Harris Denman Co., 31 Main St. E., awarded contract for the construction of a 10 story office building including steam heating system on Main St. to W. H. Yates Construction Co., 17 Main St. E. Estimated cost $500,000.

N. Z., Wellington—New Zealand Government Railways will receive bids until Dec. 10 for induction motors and accessories.